AD NUMBER

AD368997

CLASSIFICATION CHANGES

TO: unclassified

FROM: confidential

LIMITATION CHANGES

TO:

Approved for public release, distribution unlimited

FROM:

Distribution authorized to DoD only; Specific authority; Apr 1962. Other requests shall be referred to Commanding Officer, US Army Biological Labs, ATTN: Technical Release Branch, Technical Information Div., Fort Detrick, Frederick, MD 21701.

AUTHORITY

AGC d/a ltr dtd Jun 1976; AGC d/a ltr dtd Jun 1976

AD NUMBER

AD368997

CLASSIFICATION CHANGES

TO

confidential

FROM

secret

AUTHORITY

Apr 1974 per DoDD 5200.10 document marking

SECRET

368997

VEGETATIONAL SPRAY TESTS IN SOUTH VIETNAM, SUPPLEMENT (U)

APRIL 1962

U.S. ARMY CHEMICAL CORPS
BIOLOGICAL LABORATORIES
FORT DETRICK

COPY [redacted] OF 50 COPIES

SECRET

699-62

U.S. ARMY CHEMICAL CORPS RESEARCH AND DEVELOPMENT COMMAND
U.S. ARMY BIOLOGICAL LABORATORIES
Fort Detrick, Maryland

The work reported here was performed under Project 4B11-01-004, Anticrop Warfare Research, Task -01. The in-house expenditure order was 2201405. The work in Vietnam was done under expenditure order 1203001.

James W. Brown

Crops Division
DIRECTOR OF BIOLOGICAL RESEARCH

Project 4B11-01-004

April 1962

This document or any portion thereof may not be reproduced without specific authorization from the Commanding Officer, Biological Laboratories, Fort Detrick, Frederick, Maryland.

This document contains information affecting the national defense of the United States within the meaning of the Espionage Laws, Title 18, U.S.C., Sections 793 and 794. The transmission or the revelation of its contents in any manner to an unauthorized person is prohibited by law.

Classified: SECRET

By: James W. Brown
JAMES W. BROWN

Date: 17 April 1962

(U) ABSTRACT

(U) This volume supplements "Vegetational Spray Tests in South Vietnam." It is a compilation of pertinent correspondence, reports, literature citations, and photographs that document in detail the work reported in the first volume.

(U) CONTENTS

PREVIOUS PAGE WAS BLANK, THEREFORE NOT FILMED.

SECTION I

DEMONSTRATION OF EFFECT

(S) The following message is indicative of enemy reaction to the use of chemical sprays.

"MESSAGE - DEPARTMENT OF THE NAVY

FM COMUSMAC VIETNAM

TO CINCPAC

. . . . . .

4. Enemy situation:

* * * * * * * * *

(2) Period 1 5 Mar, ARVN (Fld Comd) reported total 112 VC surrendered to GVN in An Xuyen Prov. Reasons given were defoliation, effectiveness of US Acft and being hungry and tired. 22 Mar, US Intel Advisor to Fld Command visited area with ARVN Intel and GVN PsyWar officers. US Advisor talked with Dist Chief Thoi Binh Dist (WR 220430) and Dep Chief An Xuyen Prov. Local officials consider all 112 as "Communists" variously interpreted as VC, but only 9 were accepted later as being VC Guerrillas. Some of the group admitted they knowingly and willingly supported VC by growing crops. collecting supplies and doing other work. US Advisor saw a group of 20, incl some women, but they would not talk in his presence. Group gave defoliation as primary reason for surrender. Dist Chief had earlier announced he was going to employ defoliants in his operations. Defoliants used in area near coast were described by local inhabitants as quite effective, i.e., plants had changed color and many were dead. The psychological effect of Dist Chief's announced plan to employ defoliants and visual effects observed, reportedly caused surrender. Group believed their crops and source of food would be cut off. Further details reported when available.

DTG 231045Z Mar 62"

(S) It is worthy of note and emphasis that this reaction is credited to enemy observations of effects achieved by the spray elsewhere, an announced plan to spray, and a realization by the enemy group of what these sprays could do to their crops and food supply. A keen awareness by them of what

real hunger means is readily apparent and is in sharp contrast to the skepticism previously held by many US military and civilian decision- and policy-makers in regard to the potential to be achieved with a capability to attack and destroy the food supply of an enemy. The suggestion is clear that the threat to their food supply in the above instance was sufficient to cause their surrender. How many other concepts of warfare have influenced the enemy sufficiently, by the threat to his survival, to cause his surrender? Oddly enough, employment of this concept leaves it up to the enemy just how long he chooses to withstand hunger prior to surrender and in the meantime his combat effectiveness and/or labor production diminishes. Those having experienced real hunger are particularly vulnerable.

SECTION II

VEGETATION CONTROL INFORMATION

24 February 1950

1. Agents

Butoxyethanol esters of 2,4-dichlorophenoxyacetic acid and of 2,4,5-trichlorophenoxyacetic acid appear to offer the best means of chemically killing the vegetation likely to be encountered. Without knowledge of proportions of forest species to be treated it appears that a 50-50 proportion of these agents would be desirable, if pines or conifers and hardwoods are in about equal proportion. A commercial preparation of these agents is marketed by AmChem Products, Ambler, Pennsylvania as Dinoxol and contains 2 pounds of each chemical per gallon.

A recent report of experiments in Louisiana is inclosed (Inclosure 1). In these experiments the effort was primarily selective, i.e., to take out hardwood species (2,4,5-T). If conifers or pines are a problem then 2,4-D should be applied.

It is estimated that spraying should be timed to start about the middle of May and be completed before about 1 July.

2. How Applied

The most feasible means of application for treating large areas is by aerial spray. The operation performed at Camp Drum in June 1959 utilized an experimental spray rig installed in and on an H-21 helicopter. This rig and tank (100 gallon) are currently at Fort Detrick. However, an industrial recommendation, if followed, would call for disseminating 6400 gallons or 64 loadings for each square mile (1 gallon of agents diluted with 9 gallons fuel oil #2 - apply at rate of 10 gallons per acre). It is therefore suggested that perhaps the Marine Corps may be interested in using jet aircraft equipped with 14B spray tanks (90 gallons per tank - 2 tanks per plane) as a training exercise. In the operation performed at Camp Drum pure undiluted agent was disseminated and required approximately ½ loadings (100 gallons each) per square mile. Agent rate at Camp Drum was about 6 pounds per acre. The industrial agent rate would be about 4 pounds per acre (in 10 gallons).

Another suggestion for consideration would be to explore the possibilities of Air Force cooperation using an HOURGLASS spray system (1000-gallon spray tank - 2 of which could be mounted in a B-29 if there are tanks and aircraft still available).

3. Amounts Required

Approximately 4 [illegible] 6 pounds of active ingredient per acre (2.6) to 384 pounds per square mile) would be recommended. A commercial product such as Pinexol is sold as a liquid with 4 pounds active ingredient per gallon. A gallon such as this may weigh approximately 10 pounds and probably costs about $5.00 per gallon. It is estimated that the agent, if purchased, for the Camp Drum operation to treat 4 square miles would have cost close to $30,000 or about $7,500 per square mile. If acquisition of agent is to occur, CmlC Materiel Command is the procuring agency.

4. Effectiveness

The final results are not available from the Camp Drum operation and will not be until observations can be made this coming summer. Top kill of sugar maple appeared good to excellent in the treated area a month or so after application. Whether root kill was extensive remains to be seen. Applications were made later in the growing season than would have been chosen.

There does not seem to be commercially available a product specifically recommended for destroying pines, however, the butoxyethanol ester of 2,4-D appears to be as good as any compound presently known and available in quantity.

The Louisiana experiments (Inclosure 1) indicated an average top kill of 70 per cent for hardwoods native to the area. This result was obtained applying 2 pounds of 2,4,5-T (BE) per acre.

AmChem Products recommends at least 2 pounds per acre of 2,4-D (BE) if pines are to be eradicated.

5. Type of Effect

The effect to be expected will be that of ultimately killing the vegetation. During the process the leaves will die first but not necessarily fall from the trees very rapidly. At Camp Drum there was some indication of premature leaf fall (depending on species) one month after treatment.

Controlled burning of the area after general leaf fall may contribute materially to clearing an area and preventing basal sprouting of hardwoods whose roots may survive. Ultimate death of woody species either trees or brush cannot be determined prior to the next growing season.

The undersigned is available for consultation if required.

1 Inclosure

J. W. BROWN
Deputy Chief, Crops Division

Inclosure 1

EFFECTIVENESS OF AERIAL APPLICATION OF HERBICIDES FOR HARDWOOD CONTROL IN LOUISIANA*

Fred A. Peevy[1] and Paul Y. Burns[2]

INTRODUCTION

The control of undesirable woody plants is one of the biggest land management problems on non-crop land in the South. There are more than six million acres of pine sites in Louisiana alone that are in need of cull hardwood control (12). Large acreages of similar stands and sites are located in other southern states. Because of the competition for land and increased demand for raw materials, many landowners have realized the necessity of utilizing their land to the fullest extent.

In general, the low-volatile esters of 2,4,5-trichlorophenoxyacetic acid (2,4,5-T) and 2-(2,4,5-trichlorophenoxy) propionic acid (silvex) are effective on many species commonly encountered in upland hardwood areas when applied as aerial sprays. An ester of 2,4,5-T has proved to be better than esters of 2,4-D and mixtures of esters of 2,4-D and 2,4,5-T for control of blackjack and post oaks (2,4,5). Also, esters of 2,4,5-T and silvex are more selective on pines and other conifers than 2,4-D (1,2,4). Two pounds per acre of a low-volatile ester of 2,4,5-T applied as an aerial spray has not caused excessive damage to pine seedlings one year old or older (2,4,6,9,11). Most research workers agree that application of the herbicide in a 1:3 ratio of oil and water is suitable for aerial application, because the larger droplet size of emulsions compared with oil alone reduces drift hazards (3,4,5,8). The use of low-volatile esters of these phenoxy herbicides reduces hazard to crop plants (2,4).

Foliage sprays have been found to be most effective from about May 15 to July 1 in the South (2,4,5,8,10). For best results, the herbicides need to be absorbed and translocated through the stems and to the roots of the hardwoods. This translocation seems to be closely associated with organic foods (3). The rate of translocation away from the point of application is generally slow. The herbicides move through the phloem tissue of the plant,

* Excerpt from "Weeds," Journal of the Weed Society of America, Vol. 7 No. 4, October 1959.

[1] Range conservationist, Crops Research Division, ARS, USDA, cooperating with the Southern Forest Experiment Station, Forest Service, USDA, Alexandria, Louisiana.

[2] Director, School of Forestry, LSU, Baton Rouge, Louisiana.

and if the concentration in the carrier is too strong the plant tissue may be killed at the point of application before it can be absorbed and transmitted to the stem and roots (2,3).

Hardwoods were killed in Louisiana with 2 pounds per acre of propylene glycol butyl ether esters of 2,4,5-T in an oil-water emulsion applied at 5 gallons per acre during May. Treatments in September 1955 and in April 1956 gave insufficient kill of hardwoods for good growth of pines (2). Good control of pole-size maple and oak has been obtained in the Lake States from the application of 1 pound per acre of an ester of 2,4,5-T (1). Single applications did not give desirable control in Oklahoma and additional control was obtained with re-treatments (5,8).

Aerial spraying is advantageous in that low volumes can be applied uniformly over large areas, and large hardwoods are treated along with low brush. Disadvantages include possible drift of herbicides to sensitive cultivated plants, failure to reach all understory vegetation, and failure to kill some species. The season for aerial application of herbicides for woody plant control usually coincides with the time sensitive crop plants are being grown. State regulations regarding use of these materials must be observed.

Literature Cited

1. Arend, J.L. Tolerance of conifers to foliage sprays of 2,4-D and 2,4,5-T in lower Michigan. Lake States For. Exp. Sta. Tech. Note 437, 2 pp. 1955.
2. Burns, P.Y. Season of application in aerial spray for pine release. Proceedings of the Chemical Pine Release Symposium, Dow Chemical Co. March 6, 1958.
3. Coulter, L.L. A layman's discussion of the herbicides used in pine release. Proceedings of the Chemical Pine Release Symposium, Dow Chemical Co. March 6, 1958.
4. Darrow, R.A. Aerial spraying with 2-(2,4,5-TP) and 2,4,5-T for control of post and blackjack oaks. Proc. Southern Weed Conf. 10:120-123. 1957.
5. Elwell, H.M. Chemical control of brush for grass production. Proc. Southern Weed Conf. 7:245-256. 1954.
6. Hawkes, Carl. Planes release tree plantation. Jour. For. 51:345-348. 1953.
7. McIlvain, E.H. Shinnery oak is yielding to 2,4-D. Down to Earth 8(4):6-7. 1953.
8. Peevy, Fred A. Methods for controlling hardwoods. Forests and People, third qtr. issue, 1956.
9. Ray, Hurlon. New developments in chemical brush control in Arkansas. Proc. Soc. Am. Foresters, pp. 55-58. 1956.
10. Research Committee, Brush Control, Southern Weed Conference. Control of undesirable hardwoods in forests. Proc. Southern Weed Conf. 11:33. 1958.
11. Silker, T.H., and Darrow, R.A. Aerial applications of 2,4,5-T and silvex for hardwood control and increased forage production in scrub-hardwood-pine stands in east Texas. Proc. Southern Weed Conf. 9:130-133. 1956.
12. Southern Forest Experiment Station. Forests of Louisiana, 1953-54. Forest Survey Release 75, 63 pp. 1955.

[redacted]

SECTION III

MAGRD-CH 25 July 1961

MEMORANDUM FOR: Colonel [illegible]ech, Chief, R&D ARVN

SUBJECT: R&D Tasks No. 2 and 20 (U)

An estimate of the situation for Tasks No. 2 and 20 indicates that on or about 1 August 1961 the following materiel and personnel will be available:

1. 2 Aero 14-B Spray Tanks complete, 1 Marine Corps technician for installation and functioning instruction and for which 1 AD-6 VN aircraft will be required.

This system is for test use only. Loan basis. Task No. 20.

2. 1 Spray rig complete, 1 Air Force technician for installation, functioning and maintenance instruction, 1 Air Force Captain (pilot) for pilot instruction. One VN C-47 aircraft will be required. This system is for test and subsequent full scale operation by VN. Task No. 20.

3. 2 HIDAL spray assemblies for H-34 VN aircraft. At least one H-34 aircraft will be required for installation for Task No. 2. If an additional H-34 VN aircraft is made available it could be used for spraying in connection with Task No. 20 or as a ready replacement aircraft for Task No. 2. Loan basis.

4. 1 "Buffalo" turbine sprayer towed by jeep or suitable truck. This system is a self-contained unit mounted on a single axle which could prove very useful for roadside spraying in conjunction with Task No. 20.

It is suggested that test site selections be made in advance of equipment readiness where representative vegetation can be sprayed and ground access to certain or a few of these sites is possible. These sites should be known in advance to pilot and operating personnel in order for them to become familiar with the location and characteristics of particular sites of concern to them. Operating personnel should be indoctrinated in equipment functioning and operation prior to equipment readiness for test missions. Thus, selection of appropriate VN mission personnel is suggested at this time.

Photographic coverage before, during and after the various spray missions would be desirable.

Copy furnished:
Chief of Staff
Dr. Brown
Ch, AF Div
Ch, Navy Div

VIRGAL R. CHILSON
Colonel, GS
Chief, R&D Division
MAAG Vietnam

SECTION IV

PROBLEMS ENCOUNTERED IN C-47 DISSEMINATION

It was reported a day or so prior to Test 2 that the gasoline engine was laboring abnormally to supply 30pounds' pressure in the system and doubt was expressed that it could function reliably throughout the Test 2 mission (the first test using the C-47 equipment). Efforts to obtain a new engine for the pump locally were unsuccessful. It was discovered after the test that dual valves actuated by a single connected lever were out of synchronization. These valves were located on either side of a "T" on the discharge line from the pump. As the lever was actuated for spraying, one valve, which had been allowing the liquid chemical to recirculate to the tank, was closed, and the other valve opened, directing the liquid to the spray booms. The ultimate effect was that (a) both valves were partially opened or (b) one of the valves may have been fully opened (or closed) while the other was not. Both conditions could obviously have reduced the flow rate through the spray nozzles and are believed pertinent only to Test 2. Nevertheless, in all subsequent tests with this system there was a constant effort to get a maximum flow rate, because the system was designed for operating flow rates that were only one-third of the present requirement and that, if obtained, could only approach or equal the desired deposition rate. It is critically important to recall that only two pounds of each of the chemicals were in each gallon and that one gallon per acre was the requested "ball park" deposition rate. If the flow rate was one gallon per acre, losses from spray dissipation would be bad enough to tolerate, but adding a reduced flow rate to these losses could very easily have resulted in a sublethal deposit at this site. Even the portion of the site planned to receive two gallons per acre was not expected to be severely overdosed. Species selectivity had been established many years ago; that is, the effect of the two chemicals in this one solution would not be expected in all instances to be additive on a single given species, but that species might respond principally to only one of the two chemicals. Put another way (and bearing in mind the species encountered in Vietnam are largely unknown), of four groups of species, A, B, C, and D, one of the chemicals may be very effective on groups A and B; the other may be effective on Groups B and C, leaving D to represent species resistant to either chemical. Further, depending on environment, size, age, condition, and state of growth, the chemical requirements for Group A, B, or C species may range from less than one to perhaps five pounds per acre for killing effect.

Minor re-engineering of the C-47 spray equipment can make this a useful system for vegetation control.

[redacted]

SECTION V

VN INTELLIGENCE ABSTRACT

(C) The following abstract of VN intelligence concerning VC efforts to learn of the spray work was given to the writer on 7 October 1961: "G2 DOCUMENTS - SAIGON-CHOLON Executive Committee issued the following directive. Recently planes have come and sprayed chemicals at DON THUAN and LOC HUNG communes in the province TAY NINH. Twenty-four hours later, after the spraying, all crops were destroyed entirely. So whenever enemy planes come to spray, recipients of this directive must follow up and report all details to this committee in order to find out a counter measure to cope with the situation or to make denunciation.

(C) A reliable source of information reports that at present the enemy are preparing to use poisonous gas to kill crops and human lives. A special study organization has been activated.

(C) HANOI radio broadcasting station denounced that we used poisonous gas to kill crops and human lives on 2nd Oct 61."

(C) Prior to departure in February, the writer was told that the VC were moving out of areas where they anticipated sprays to be delivered, fearful of being exposed to these sprays and believing their own propaganda that they would be killed by "poisonous gas." (That these vegetation sprays as delivered were poisonous to people is utterly untrue.) Section V of this Supplement is a pertinent abstract from a VN Intelligence bulletin.

SECTION VI

SUMMARY REPORT

VEGETATION CONTROL, CAMP DRUM

J. W. Brown

28 October 1959

CONTENTS

INTRODUCTION

It is emphasized that the vegetation control mission at Camp Drum was conducted under conditions prevailing and choice of operation was thereby limited. Biological Warfare Laboratories' total part in the mission was completed in eight days and was controlled exclusively by "What is available to do this job?"

Because the area in question was an artillery impact area, access to it on the ground was not possible. Thus, such things as a spray sampling grid, detailed observations on the site, and course markers for the aircraft could not be set up or performed.

It is not proposed that the spray equipment which was used is a desirable end item for mass production— it was the only equipment available with which to do the job. It is believed, however, that as a result of this experience, a simpler spray system could be designed and fabricated which could better serve the purpose.

Because of the above circumstances, the following information will vary from general to specific and will contain estimates where specifics are lacking.

A short movie is nearing completion which contains shots of the spray operation and effects on vegetation one month after the first spray mission.

---

a. Agents Utilized

The agents obtained for this operation were: Butyl 2,4-dichlorophenoxyacetate (A) and Butyl 2,4,5-trichlorophenoxyacetate (B).

Although these materials were originally a part of an Air Force acquisition, they had been surplussed and were in the possession of the U.S. Department of Agriculture at Beltsville, Maryland. Thirteen drums (@ 55 gallons) of each agent were obtained for the original mission in June or a total of about 1430 gallons or 15,300 pounds. It is understood that later Camp Drum directly acquired an additional 800 to 900 gallons of agent from this source and exhausted this supply. Subsequent inquiries have revealed that no other bulk supply of these agents exists in the Army, Air Force or Department of Agriculture.

(1 Effects Characteristics

These agents, after being sprayed on the foliage of vegetation, enter the plant systems, are translocated, disturb the normal physiology and in sufficient quantity, ultimately cause the death of susceptible species.

Younger vegetation generally is more sensitive than mature vegetation. Mature trees are more difficult to kill depending on the extent of internal transport of the material. Thus, the tops may be killed while the root system may not and regeneration may occur at the base of the tree. To insure best results, timing of the spray application should be planned for spring application when the trees have just leafed out fully and growing conditions are good. The applications at Camp Drum were judged to be applied one month to six weeks later in the season than would have otherwise been chosen. Although top kill of sugar maple appeared extensive one month after treatment, the degree of root kill will remain unknown until next spring. It has been suggested to Camp Drum that a controlled burning of the four square mile area after the leaves fall from the trees this fall could give greater assurance of preventing basal regeneration.

(2) Physical Characteristics

Both of these agents were in pure form, that is, no diluents, spreaders, or surfactants were added. At temperatures above 70-75°F. both are liquids. Agent A remains a liquid at temperatures as low as 0°F. Agent B tends to crystallize at about 70°F or lower. At Camp Drum Agent B varied from slushy to almost solidified. A one-to-one mix of the agents was desired so a drum full of liquid A was circulated through a heater in and out of a drum of liquid B to liquify B and achieve the mixing. The liquids together had characteristics of liquid A in regard to temperature.

In pure chemical form Agent A has a density of about 1.25 grams per milliliter and Agent B about 1.33 g/ml. and weigh approximately 10.4 and 11.1 pounds per gallon, respectively. The 1-1 mix of these agents weighs about 10.75 pounds per gallon.

(3) Other Candidate Agents

For the Camp Drum operation the agents used were, fortunately, the agents of choice. Perhaps the addition of fuel oil might have enhanced uniformity of coverage of influenced droplet size or breakup favorably but time was so pressing it was not added. The oil could have been added at about 1 part oil to 1 part agent mix.

Other agents suitable for use on other vegetation and other purposes of vegetation control are listed at the end of this section.

b. Dissemination Equipment Utilized (during mission)

(1) Description of Spray Systems Pump and Engine

Pacific pump - centrifugal, 100 gallons per minute capacity

Onan engine - 2 cylinders, 4 cycle, gasoline powered, 6.5 - 10.1 horsepower

The pump, engine, two 55-gallon stainless steel tanks, necessary valves and gauges are mounted as a unit on an aluminum I-beam framework. The pump and engine are mounted between the tanks. Empty weight of this unit is about 600 pounds; fully loaded - about 1800 to 1850 pounds.

(2) Agent Reservoir Capacity

Two 55-gallon stainless steel tanks with sight gauges and vents. Total capacity 110 gallons.

(3) Spray Boom

Over-all length of assembled spray boom is about 23 feet, composed of two 10-foot sections of 1-inch stainless steel pipe joined to a central 3-foot T-section mounted centrally under the fuselage at right angles to it so that minimum ground clearance of at least 12 inches was obtained.

(a) Type Nozzles

Spray Systems, Inc., Whirljet B-2 nozzles were used.

(b) Number Per Boom

Twelve nozzles were operated at each end of the boom or a total of 24 nozzles. Spaces and taps are provided for mounting 25 nozzles at each end of the boom for a total of 50 nozzles. Nozzle spacing is about 4 inches.

(c) Flow Rate Per Nozzle

Each nozzle will deliver 0.4 gallons per minute at 35 to 40 pounds per square inch in the line.

(d) Total Flow Rate

At 35 to 40 p.s.i. the total flow rate was estimated to be 9.6 gallons per minute.

(e) Estimated Particle Size (MMD)

Particle size of the spray is estimated at 250 microns MMD.

(4) General Statement on Suitability of Helicopters for this Type Operation

It is believed that helicopters have many attributes which are suited to this type of operation. Among them are maneuverability, slow flying speed, weight-lifting capacity, limited area landing to reload, visibility for observation and ability to aim spray, and safety especially for low level flying. However, vibration of these aircraft under heavy load requires securing internal stores. This type of aircraft may require somewhat more servicing during operational use.

In instances where the aircraft released spray at about 75 feet above the tree tops, the ribbons of spray retained their structure downward (and outward when influenced by the H-21 dual exhausts) under the rear rotor and then rose to coalesce and mix in turbulence some distance (25 to 50 yards) behind the aircraft. However, when the aircraft was only 25 or so feet above the trees, the ribbons of spray on their downward sweep appeared to enter the canopy and not reappear. Swath widths under the latter conditions were apparently limited to perhaps twice the spray boom length. It was felt desirable to try for release at about 75 feet above the trees in order to obtain swath widths on the order of 300 feet or greater.

Fixed wing aircraft would have been suitable for releasing the agent but were not available.

(a) Helicopters Other than H-21 that Could be Used

The experimental spray equipment was originally fabricated for use and used in the H-19 helicopter. It is believed that a simpler rig could be fabricated where the 55-gallon drum of agent could be carried in the aircraft as the "spray tank" and be replaced as needed. Flexible hoses to a pump mounted in the aircraft could supply the agent from the drum to the pump to the spray boom. It would appear that a helicopter capable of carrying one or more drums of agent, the pump, spray boom and operator could be utilized.

c. Performance and Results

(1) Airspeed during Mission

Airspeed during the mission was about 30 miles per hour. The supply of nozzles was a limitation here. A speed of 60 mph is recommended for greater safety.

(2) Estimated Deposition Per Unit Area

An attempt was made to average 5.5 to 6.0 pounds per acre coverage over the 4 square mile area. During the five missions attended by Biological Warfare Laboratories personnel (of 15 scheduled), winds were S-SW at 5 to 7 miles per hour, temperature about 80°F, overcast sky, weak lapse condition. Passes were made at about 75 feet above the canopy at 30 miles per hour. Flight paths were perpendicular to the wind direction and spaced approximately 300 feet.

(3) Degree of Canopy Penetration Achieved

From aerial observation about one month after spraying, it appeared that canopy penetration varied somewhat, that is, the greater penetration occurred almost directly under the flight paths with somewhat lesser penetration fading off downwind of the flight path. This appearance may have resulted from a gradation in application as distinguished from penetration per

se. Skips were observed at this time which were perhaps due to pilot error in flying equispaced parallel courses. It is understood, too, that different pilots were assigned to the operation as it progressed after the departure of Biological Warfare Laboratories personnel.

In other vegetation control trials conducted by Biological Warfare Laboratories personnel, penetration to the forest floor was readily achieved in moderately dense stands.

(4) General Description of Forest Treated (Canopy and Undergrowth)

(a) Type

The forest trees in the area were primarily sugar maple. White pine was also present as were some basswood, cherry, poplar, birch and others. Tree size varied from seedlings to trees 50 to 60 feet in height.

(b) Density

The sugar maple was interfering with visibility in observing artillery shell bursts and killing or defoliating this species was desired. The white pine was not present in the area of interest to an extent that it interfered with visibility, nor by its growth habit was it likely to interfere greatly in the future. The coniferous species generally are not susceptible to the agents used. The maple undergrowth appeared to be sparse. A part of the area was not forested or forested only sparsely. Grasses were the main vegetation in these areas and were not of concern.

(5) Effects on Foliage

(a) Time Required

The foliage undergoes a color change similar to that of fall coloration after treatment with the agents used. The process may be completed in two to three weeks with the leaves wholly brown and somewhat shrivelled at the end of this time. The vegetation was observed about one month after the first spraying and foliage was brown and dead at that time. It is desirable to discover agents which are more rapid in their action.

(b) Defoliation, Desiccation, Kill, Etc.

One month after treatment the leaves were in the main still attached to the maple trees, however, unseasonal leaf drop had commenced. The leaves were desiccated at this time. The general appearance of the maple trees was that they were killed.

(c) Estimated Final Results of Mission to Treated Area

There is reasonable expectation that good to excellent kill of the maple trees was achieved. The degree of top kill appeared quite high--

that is, if the trees got sprayed the tops were killed. The extent of root kill cannot be fixed at this time. Observations next spring would be necessary for an estimate of this kind.

d. Statement of Opinion on Future Potential and Need for Vegetation Control

The use of chemical agents and formulations to achieve control of vegetation has increased many-fold in the past 10 to 15 years. The problems of control vary considerably. To name a few: Railroads are using chemicals to clear their roadbeds of all vegetation; power line rights-of-way are cut over first where necessary and chemical sprays used to keep them clear; roadsides ditch banks and streams are cleared of unwanted vegetation by using chemicals; fire breaks are maintained by this means; and chemicals are used to eradicate weeds selectively from desirable crops.

Although some of these uses may coincide with vegetational problems the military are currently recognizing, research and development of agents and techniques devoted to military vegetational problems, including those set forth in the Combat Development Objectives Guide (1239d), is desirable. Research for these purposes is not currently funded nor has it been since defoliation research was discontinued by directive in 1957.

While the Camp Drum operation could only be conducted feasibly by aerial dissemination, the clearing of vegetation from the perimeters of missile sites appears to require in many, if not most, instances that ground operations be performed. Close control of sprays and spray drift is required where the site property is adjacent to private property where ornamental plants and/or agricultural crops may be susceptible to damage by the chemicals used. Under these conditions the use of chemicals having high volatility would also be contraindicated. Certain states require licensing to disseminate aerial sprays in order to control or limit unintentional damage to susceptible crops.

Chemicals are commercially available which can accomplish these tasks by killing essentially all vegetation, killing broadleafed species and leaving grasses, or killing grasses and leaving broadleafed species. The user must be prepared to live with the result of the chemical action such as erosion of bare ground or creating dust or mud conditions. If grasses are acceptable as remaining vegetation, then provision for moving or perhaps using sublethal rates of chemicals as needed for controlling grasses will prevent or minimize a fire-hazard. Killing trees, for instance, does not remove the trees, thus, where access to the area on the ground is allowable and removal of the trees is desired, they may be cut down before or after killing--spraying the stumps of freshly cut trees is a customary practice to prevent basal sprouting of some broadleaved species. Also trees have been killed by spraying the stem of the tree all around one to three feet above ground, or frilling the stem in this region with a circumferential ax cut and pouring the chemical in this cut. Obviously, less agent is required per tree with this method than is required to spray the whole crown. On the other hand tackling a large forested acreage by this means would be extremely time consuming.

The methods used at Camp Drum required the labor of a small group and, if the spraying time were condensed, only about two days devoted to spraying were required to bring about the death of trees on approximately 4 square miles of land. More importantly, this was an area in which ground operations could not be conducted because of the hazard of unexploded shells.

It would seem that if it is desirable for real estate of this kind to be cleared, chemical spraying is the most feasible method to be used.

Another important facet of vegetation control potential is the visibility obstruction, security and fire hazard problems posed by vegetation surrounding missile sites and in which Army Air Defense Command has an interest. Their interest in using chemicals to attack these problems has been stimulated by the results so far achieved at Camp Drum. A trip report to Headquarters, 1st Army, Governor's Island, New York, and pertinent inclosures, was distributed 13 October 1959 and is pertinent to vegetation control at missile sites.

The Deputy Army Surgeon, 1st Army, was interested in the use of chemicals in the eradication of poison ivy in troop training areas in order to reduce man-days incapacitation because of this pest.

COMMERCIALLY AVAILABLE CHEMICALS

For Killing Brush and Woody Species

Weedone Brush Killer 32 - Amchem Products, Inc.
(Butoxyethanol ester formulation containing 1 1/3 pounds of 2,4-dichlorophenoxyacetic acid (2,4-D) equivalent and 2/3 pounds of 2,4,5-trichlorophenoxyacetic acid (2,4,5-T) equivalent per gallon.)

Weedone Brush Killer 32 is a mixture of 2,4-D and 2,4,5-T used primarily to control woody plants in hedgerows, pastures and roadsides. It is also effective in choke-cherry control and for poison ivy control in orchards. It can be used as an over-all spray, emulsified directly in water, in combinations of water and oil, or used in oil alone (diesel oil, #2 fuel oil, or kerosene). It is especially formulated to emulsify or "mix" in 10 gallons of oil to make 100 gallons of spray. It is used as a basal spray or for stump treatment to prevent resprouting.

This material is made from low volatile esters, so that "vapors" or "fumes" from this material are minimized making it safer to use near crops sensitive to 2,4-D or 2,4,5-T injury.

Weedone Industrial Brush Killer - Amchem Products, Inc.
(An emulsifiable concentrate containing 2 pounds each of the butoxyethanol ester formulation of 2,4-D and 2,4,5-T acid equivalent per gallon.)

This material is especially formulated for control of brush along roadways, rights of ways, and industrial installations. In using this material care must be exercised when spraying in the vicinity of susceptible plants such as beans, grapes, etc.

Weedone 2,4,5-T - Amchem Products, Inc.
(Butoxyethanol ester formulation containing 4 pounds of 2,4,5-T acid equivalent per gallon.)

Weedone 2,4,5-T contains a low or non-volatile ester and little danger exists from "vapors" or "fumes" of this material drifting to nearby 2,4-D sensitive crops. This material can be used as a brush killer in areas where Weedone Brush Killer 32 would not be as effective on certain woody species as would Weedone 2,4,5-T and for horsenettle control. Weedone 2,4,5-T is more effective than Weedone Brush Killer 32 on thorn apple, and some other woody plants such as Ash, Red Maple, etc.

For Killing All Weedy Vegetation

Karmex W - Dupont Chemical Company
(3-parachlorophenyl 1, 1 dimethylurea formulation containing .8# of active ingredient per pound.)

Karmex W is a water dispersible powder formulation for use as a soil sterilant and for use on established asparagus beds at much lower rates. It should be used where a complete kill of all plant life is desired. It should not be used between or adjacent to desirable plants, ornamentals or trees. Before attempting to use Karmex W read instructions on wettable powders carefully.

Karmex DW - Dupont Chemical Company
(A wettable powder formulation containing 0.8 pounds per pound of (3-)3,4-dichlorophenyl) -1,1-dimethylurea.)

Karmex DW used at low rates 1 to 6 pounds per acre has given good to excellent annual weed and grass control in a wide variety of crops. In G.L.F. territory the material has been adopted for use in grapes and potatoes. Due to its long residual and wide range of toxicity to plants, high rates of the material have been effective in sterilizing soils where no plant growth is desired.

Ammate - Dupont Chemical Company
(Water-soluble formulation containing .95# ammonium sulfamate per pound).

Ammate is a non-selective weed killer which can be used to eliminate undersirable weeds around home areas, areas open to the public, fencerows and other areas where the control of all vegetation is desired. It is non-poisonous, non-flammable and non-hazardous to humans, as well as livestock, when used correctly. It can be used as a spray or mixed with sand and applied dry. It is both a contact and a translocated herbicide with a relatively short residual activity.

Simazin 50 W - Geigy Chemical Company
(A wettable powder containing .5 pound (2-chloro-4,6-bis-(ethyl-amino)-5-triazine) per pound of formulated material.)

At high rates Simazin has been effective in controlling plant growth around industrial installations, roadways, etc., where no plants are desired.

Weedazol - Amchem Products, Inc.
(A water-soluble salt formulation of 3 amino, 1,2,4-triazole).

Weedazol is a newly developed water-soluble herbicide which has shown great promise as a control for a variety of perennial weeds. It is readily translocated and is selective in its action. Suggested for use on Canada thistle, poison ivy, etc.

SECTION VII

CHRONOLOGY OF TESTS

Test	Date of Treatment	Location	Equipment	Chemical	Date of Observation
1	10 Aug 61	Kontum	H-34	Dinoxol	28 Aug (air)
					11 Oct (ground)
2	24 Aug 61	Chon Thanh	C-47	Dinoxol	28 Aug (air)
					7 Sep (air)
3	25 Aug 61	Mangrove	AD6	Dinoxol	7 Sep (air)
					13 Sep (air)
					14 Sep (air)
					20 Sep (air)
					15 Oct (air)
					24 Oct (air)
					28 Oct (air)
					31 Oct (air)
					7 Nov (air)
					16 Nov (air)
					2 Dec (air)
					3 Jan (air)
4	7 Sep 61	Chon Thanh	C-47	Dinoxol	8 Sep (air)
					20 Sep (air)
					16 Oct (air)
5	13 Sep 61	Mangrove	C-47	Conc. 48	Same as Test 3

Test	Date of Treatment	Location	Equipment	Chemical	Date of Observation
6	14 Sep 61	Mangrove	C-47	Trinoxol	Same as Test 3
7	17 Oct 61	Bien Hoa	C-47	Trinoxol	20 Oct (air)
					24 Oct (air)
					28 Oct (air)
					31 Oct (air)
					7 Nov (air)
					16 Nov (air)
					2 Dec (air)
					15 Dec (air)
					3 Jan (air)
					8 Jan (air)
					22 Jan (air)
8	17 Oct 61	Chon Thanh	C-47	Trinoxol	17 Oct (air)
					20 Oct (air)
					28 Oct (air)
					31 Oct (air)
					7 Nov (air)
					16 Nov (air)
					2 Dec (air)
					15 Dec (air)
					8 Jan (air)
9	18 Sep 61	ARVN	Buffalo Turbine	Dinoxol	19 Sep (ground)
					21 Sep (ground)

Test	Date of Treatment	Location	Equipment	Chemical	Date of Observation
					25 Sep (ground)
					26 Sep (ground)
					27 Sep (ground)
					12 Oct (ground)
					23 Oct (ground)
					2 Nov (ground)
					19 Dec (ground)
					23 Jan (ground)
10	29 Dec 61	Rt. 15	C-47	Pink Code	29 Dec (ground)
					3 Jan (air)
					5 Jan (ground)
					8 Jan (air)
					10 Jan (air)
					12 Jan (air)
					16 Jan (ground)
					19 Jan (air)
					22 Jan (air)
					24 Jan (air)
11	29 Dec 61	Airstrip north Rt. 15	Buffalo Turbine	Dinoxol	Same as Test 10 and also 26 Jan (ground)
		Airstrip north Rt. 15	Buffalo Turbine	CA	
		Rt. 15 near Long Thanh	Buffalo Turbine	Dinoxol	

Test	Date of Treatment	Location	Equipment	Chemical	Date of Observation
12	10 Jan 62	Pt. 15	C-123	Purple Code	12 Jan (air)
					16 Jan (ground)
					19 Jan (air)
					22 Jan (air)
					24 Jan (air)
13	12 Jan 62	Pt. 15	H-34	CA	16 Jan (ground)
					19 Jan (air)
					22 Jan (air)
					24 Jan (air)
					10 Feb (ground)
14	12 Jan 62	VN Navy Yard	H-34	CA	15 Jan (ground)
					19 Jan (air)
					21 Jan (air & ground)
					24 Jan (air)
					1 Feb (air)
15	27 Dec 61	VN Navy Yard	3-gal. hand sprayer	CA	4 Jan (ground)
16	4 & 10 Jan 62	VN Navy Yard	3-gal. hand sprayer	16 chemicals	6 Jan (ground)
					8 Jan (ground)
					10 Jan (ground)
					15 Jan (ground)
					22 Jan (ground)

Test	Date of Treatment	Location	Equipment	Chemical	Date of Observation
17	19 Jan 62	ARVN	3 gal. hand sprayer	Diquat	22 Jan (ground)
					23 Jan (ground)
					12 Feb (ground)
18	3 Feb 62	Bien Hoa	Buffalo Turbine	CA	14 Feb (ground)
USAF	13-16 Jan 62	Route 15	C-123 with Hourglass tank.	Purple Code	16 Jan (ground)
					18 Jan (air)
					19 Jan (air)
					22 Jan (air)
					24 Jan (air)
					26 Jan (ground)
					1 Feb (air)
					10 Feb (ground)

SECTION VIII

SPRAYING FORESTS BY HELICOPTER*

Helicopters may be valuable for applying insecticides to small, high-value forest areas such as Christmas tree plantations.

This is the conclusion of USDA researchers from evidence of recent tests and past limited use of helicopters in experimental and operational forest insect control.

Sprays from a helicopter were more evenly distributed across a 100-foot swath than those applied by a light, fixed-wing aircraft, in tests by ARS agricultural engineer D. A. Isler and entomologist Bohdan Maksymiuk of the Forest Service.

Moreover, because helicopters are highly maneuverable and can travel at slow speeds, operators are better able to uniformly cover spray areas. The small carrying capacity and present high operating cost of helicopters limits their use to small areas of high value. For large forests, planes capable of carrying 400 to 3,000 gallons of spray are used.

Tests with the helicopter were made as part of continuing research to determine the most efficient and economical methods of aerial application of insecticides to forests.

The tests were made at the Agricultural Research Center, Beltsville, Maryland. Isler and Maksymiuk measured the amount of spray striking the ground at 5-foot intervals along a 100-foot swath. In five flights, spray deposited from the center of the path of the helicopter to 45 feet on either side of it averaged between 0.4 and 0.8 gallon per acre.

Distribution Was Evener Than from Plane.

Most significantly, the pattern of distribution was more even than that given by a fixed-wing plane, where sprays tend to fall in heavier amounts at two points on either side of the plane, with a low deposit rate in the center.

Drop size of the spray when it reached the ground was comparable to that delivered by fixed-wing planes.

Size of drop and distribution of sprays across swaths are the two main factors in aerial application of insecticides studied by Isler, chief entomologist J. S. Yuill, and associates at the Forest Insects Laboratory, Beltsville. Three fixed-wing planes are regularly used in their experiments; the helicopter was loaned by a private company.

---

* Agricultural Research, Vol. 10, No. 8, p. 14, February 1962.

Drop size is important for effective coverage of insects and foliage. A fine spray covers more surface area than a coarse spray.

For aerial spraying of insects that defoliate trees, however, a spray ranging in the middle in drop size gives the best control. A high proportion of finely atomized sprays may be lost because of drift.

Size of spray drops, therefore, also affects distribution of the spray across the swath. In any spray, fine or coarse, there is a range in drop size. The greatest number of drops in a spray must be of a size that will reach the area to be treated and give the best surface coverage.

What makes drop size? Factors that would operate in spraying from the ground, such as size of nozzle opening and spraying pressure, have relatively little effect in the air.

Isler and Yuill find that two factors seem to be most important in regulating drop size in aerial sprays: speed of the aircraft, and the direction spray nozzles face in relation to flight direction. Velocity of the air and velocity of the spray as it meets the air cause the breakup of the liquid into drops.

Other factors besides drop size that affect spray distribution are: arrangement and location of the nozzles across the spray boom; aircraft wing span; the spiral movement of air at the wing tips; and height of the plane above the ground. Wind, humidity, and temperature must also be taken into account in designing experimental and control procedures.

Better Spray Control May Reduce Costs

The researchers hope to reduce spraying costs by developing better control of drop size and distribution. If sprays can be better distributed, less insecticide per acre may be used. Present rate of application for forest defoliating insects is about 1 gallon per acre of a spray of 1 pound of DDT in oil solution.

The entomologists are working to develop more effective sprays for various insects that attack trees.

SECTION IX

SEPTEMBER PROGRESS REPORT, 1961

Task 2. Ten drums of Trinoxol were received 4 September 1961, total 500 plus gallons.

The airstrip at Kontum was closed all month to C-47's. A trip planned for 25 Spetember was called off because of the Caribou aircraft being grounded for replacement of one engine.

Ground observation of manioc near Dak To has not been possible since the spray was made on 10 August. Airstrip closure and VC activity in the area have both interfered.

A message was received 18 September 1961 that all HIDAL equipment had been grounded, presumably because of damage to helicopter fuselages. Another message indicated a modification kit would be available in 60 days.

VN have indicated 25 September that an aerial observation would be scheduled in early October preliminary to some operational test spraying of manioc and sweet potatoes near the northern seacoast town of Hue.

Task 20. Ten drums of "Concentrate 48" were received 4 September 1961, a total of about 500 gallons, for test on mangrove.

AD-6 and 14B Spray. The test site in a mangrove area sprayed with 85 gallons of Dinoxol at 2 gallons per acre on 25 August was observed aerially on 7 September. The area was clearly visible from the air on approach. A relatively sharp demarcation of the swath was evident on the side upwind when sprayed. The effect appeared to feather off across the swath downwind. Some trees in the swath had brown leaves at this time. Photographic conditions were not good but several photographs were made. More photographs were taken on 13 September and again on 14 September. By the 14th considerable leaf fall had occurred in the test swath. By the 20th the trees in the initial (southern) end of this swath were practically leafless.

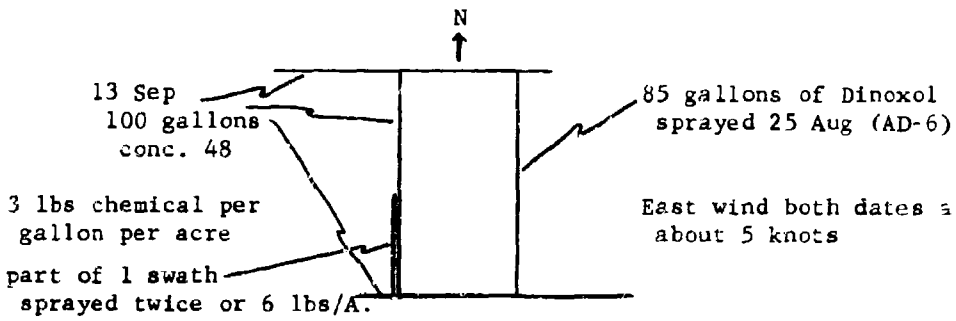
On 22 September the packing of the 14B's and associated gear was completed.

C-47 Spray. The roadside area near Chon Thanh has been observed only from the air since it was sprayed 24 August 1961. The first observation was on 7 September and the spray had obviously drifted on the west side away from the road. On the east side the location of the spray was generally good. Although the sprayed areas were clearly visible for a considerable distance from the air, more time was obviously needed for the effect to reach a maximum.

SECRET

Because of the drift of the 24 August spray away from the west side of the road, an additional 100 gallons of Dinoxol was sprayed 8 September to cover the swath of unsprayed trees adjacent to the road. At this time the sun was shining brightly and the 24 August spray effect looked very impressive.

On 13 September 100 gallons of "Concentrate 48" were sprayed in the mangrove area as shown in the diagram below:



On 14 September 50 gallons of Trinoxol were sprayed in the mangrove area in a single inwind swath with part of the swath repeated due east of the above pattern and across a river from it. A heavy rain shower fell 10-15 minutes after this spray. Estimated rates of deposit are about 4 and 8 lbs/A. Ground wind was estimated at about 18 knots with gusts from the west.

On 20 September at about 1530 aerial observations were made at the Chon Thanh roadside area and in the mangrove area. Heavy transient rain showers were encountered at both sites. All of the more recent sprays were showing effective foliar coloration. The oldest spray at Chon Thanh gives indications of either resistant species, or lack of spray penetration in places, with the latter seemingly most suspect

Buffalo Turbine Spray. The morning of 18 September, a site on the military base housing ARVN Headquarters was selected for testing the Buffalo Turbine. At about 1530 the sprayer, loaded with 50 gallons of Dinoxol (and about 5 to 10 gallons of #2 fuel oil remaining from functional tests) was towed by a jeep and sprayed the site. In this area were several unknown trees, grasses, vines, and shrubs, but bamboo, papaya, buffalo grass, and banana seedlings and trees were sprayed and all of the latter have shown considerable initial susceptibility. Extreme densities as well as open vegetation were encountered. Because of the uneveness and water soaked condition of much of the terrain the spray was delivered at no greater than a walking pace. Almost daily observations and still photographs were made through the 22nd. At the time of spraying there was but little ground wind (estimated at less than 5 knots) but observations on the 25th indicated some of the spray carried about ½ of a mile over relatively open terrain and

achieved an altitude of 50 feet or more. Velocity of the spray near the machine was great enough to flatten grassy vegetation and the spray appeared to pass or roll over rather than penetrate. However, burning tests of the buffalo grass on the 25th indicate a self sustaining fire could be started where this grass was sprayed. Of great interest is the fact that ½ hour after the spray about 16 hours of continuous rain occurred.

Notes on U.S. Personnel Tasks 2 and 20. At the expiration of their TDY the following members of the Task 2 and 20 team departed Saigon:

Tasks

2 & 20 - Mr. W. B. Johnson, DAC, 12 September 1961 to return to Fort Detrick.

2 & 20 - T/Sgt Leon O Roe, USAF, 21 September 1961 to return to Langley AFB, Virginia.

20 - Capt Mario Cadori, USAF, 25 September 1961 to return to Korea.

These men are to be commended for their various very special contributions to the missions of Tasks 2 and 20.

Remaining TDY Personnel.

Sgt James McIntosh, USMC, TDY expires 15 October 1961.

Dr. James W. Brown, DAC, TDY being extended 90 days.

Expected Personnel.

Mr. Lester Boyer, DAC, TDY o/a 5 October for 90 days.

Dr. Brown will visit Dr. Abbe of the University of Minnesota who is currently a visiting Professor of Botany at the University of Singapore 28 September, returning to Saigon on 3 October. Dr. Abbe has made a survey of forest trees in Vietnam.

Chemicals on Hand.

Dinoxol - less than 50 gallons (Task 20)
Trinoxol - about 450 gallons (Task 2)
Concentrate 48 - about 400 gallons (Task 20)
Other - about 15 chemicals ranging from a few grams to 5 pounds.

SECTION X

MAGFD-CH 12 August 1961

MEMORANDUM: FOR RECORD

1. An aerial spray test mission was performed on 10 August 1961 during the hours 1650 to 1730. The H-34 helicopter spray rig was used for these tests. This system was the first one available for any test spraying and therefore the one used to demonstrate the effectiveness of the chemical agents on:

a. the forest vegetation along a selected part of the road from Kontum north to Dak To (+ or - 50 gallons of Dinoxol - Task 20), and,

b. manioc grown adjacent to a pre-selected village north of Dak To (+ or - 10 gallons of Trinoxol - Task 2).

2. Although the primary mission was to spray the manioc for effect, the roadside spraying was performed first for the following reasons:

a. The greater amount of chemical required for the roadside test (50 gallons) could more easily be loaded into the spray tank on the ground at Kontum with equipment air-lifted from Saigon, while the chemical for manioc could be poured into the tank by hand while in the air.

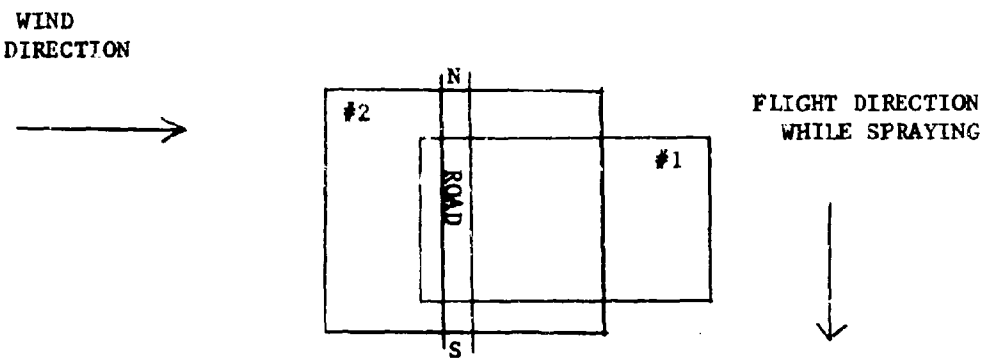
b. The roadside test area was on the way to Dak To.

c. Spraying the roadside would lighten the aircraft by 450 pounds, or more, thus making it less difficult to fly the aircraft while spraying the manioc.

d. Both spray tests could be accomplished in less time and with one flight.

3. Roadside spraying.

a. Two spray releases were made purposely in the same section of road. The first release was from the greatest height (75 to 100 feet) and was the shorter release. The helicopter flew directly over the road. A crosswind carried the spray to the east of the road. The second release was also North to South but appeared to settle about equally on both sides of the road (see map overlay obtained by Captain Chan from the Province Chief and diagram below):



b. For test purposes, the releases were excellent. It was raining a mile or two to the east of the area. It is not known whether the storm later passed over the area which received the spray. Within the total area, a generous portion received the following two estimated rates of spray: 1 or 2 gallons per acre (2.47 or 4.94 gallons per hectare). Each gallon contained 4 pounds of active chemical ingredients. The rate estimated to be sufficient is one gallon per acre. Subsequent aerial and ground observation offers an opportunity to see the effectiveness of these two rates of application. Although it is believed that some effect of the sprays could be observed within one week, the effect will increase with time until a month or two. However, it is expected that in about two weeks a relatively marked effect could be observed. The completeness of effect will be dependent on the degree or depth of penetration of the spray into the foliage. Perhaps it will be possible after two weeks to determine whether a repeat application should be made if sufficient penetration was not achieved.

4. Manioc.

a. Although three short spray passes were made it was not until the third pass that the manioc received the spray. Because of insufficient communication and the absence of smoke grenades marking the area, and indicating wind direction, the operation was more difficult to accomplish.

b. Access to the area on the ground was not possible at the time of spraying. It is quite possible that more crops were sprayed than were intended to be sprayed, including rice, banana trees, melons and perhaps others. This was explained to Capt. Chan and the Province Chief. Assurance was received from them that this was understood and did not particularly matter.

c. It is estimated that marked effects on manioc will be apparent in about two weeks.

5. Ground spray application.

a. On 11 August 1961 at about 1100 hours, some Trinoxol was sprayed on manioc, sweet potatoes, bananas and some native grasses and weeds behind the billet occupied by Capt. Chan. By 1215 the sweet potato leaves were badly shrivelled, the banana leaves had lost most of their green coloration, and the manioc leaves were markedly affected. About 75 to 90% of the native grasses and weeds appeared sensitive to the spray.

b. About ½ hour earlier, a manioc plant, some bamboo shoots and some native weeds and grasses were sprayed at the MAAG BOQ at Kontum. The manioc here was a bigger plant but was showing marked effect when observed at 1300 hours. The bamboo appeared to be somewhat resistant, later observations will be needed to confirm the effect on bamboo.

6. Notes on equipment.

a. The H-34 helicopter flew from Saigon to Kontum with the spray rig installed. Harmonic vibration in the spray booms developed to such an extent that at 80 knots the anchor positions of the booms at the upper forward stations were causing cracks in the fuselage. Major Good, USAF Advisor has been asked to report in writing about this and to make recommendations to remedy this situation. Because of this the spray booms were removed from the aircraft after the spraying was completed.

7. Personnel on spray flight.

a. Kontum Province Chief - Captain Hoang Van-Dinh.

b. Project Officer - Captain Le-Minh-Chan.

c. VN Pilot - Captain Nguyen - Dinh-Thap.

d. VN Crew Chief - Sgt. Chau.

e. U.S. pilot advisor - Major Good.

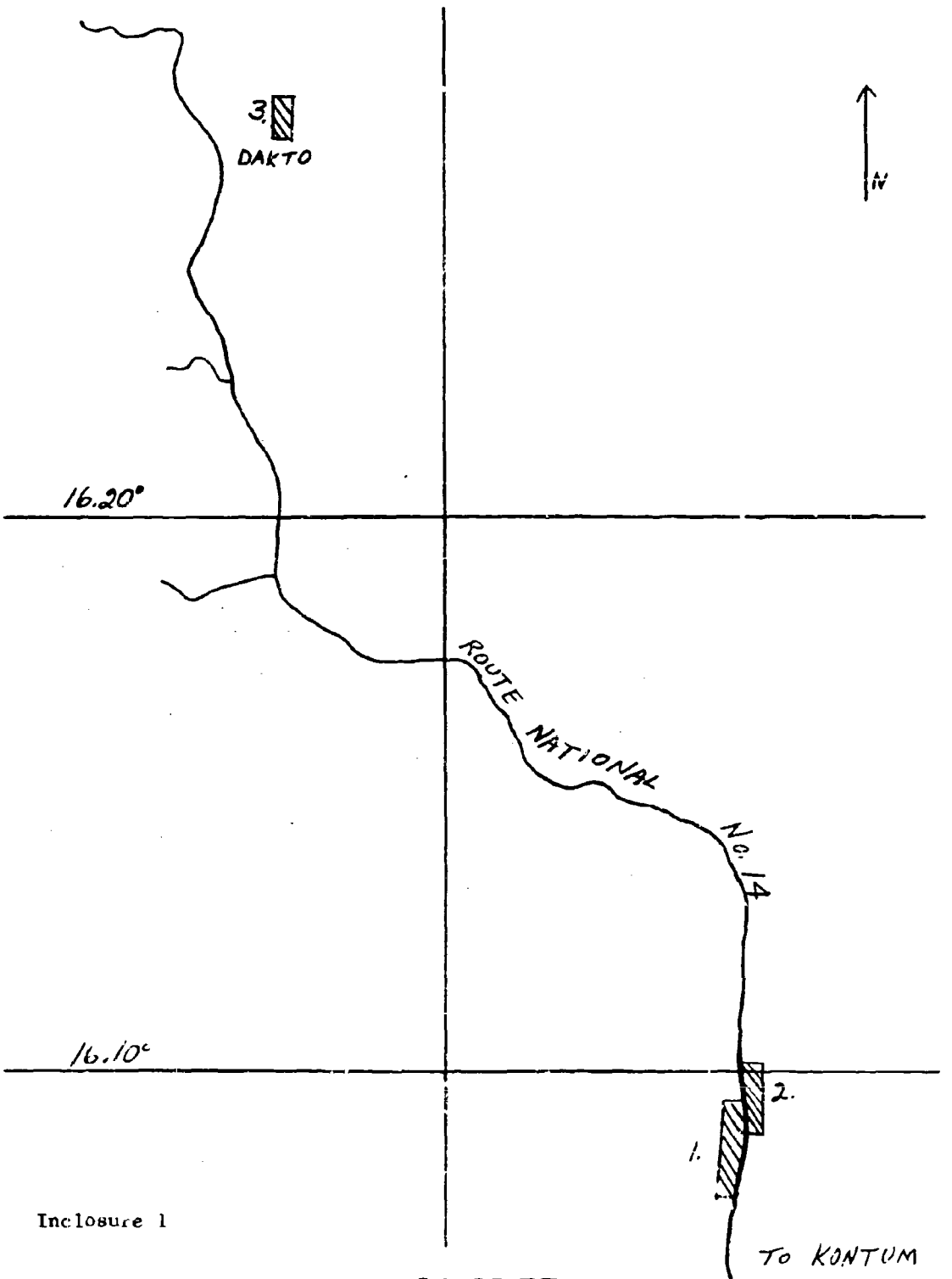
f. Mr. W. E. Johnson.

g. Dr. J. W. Brown.

1 Incl
Overlay - Spray Areas

VIRGAL R. CHILSON
Colonel, GS
Chief, R&D Division

SECRET



Inclosure 1

SECRET

SECTION XI

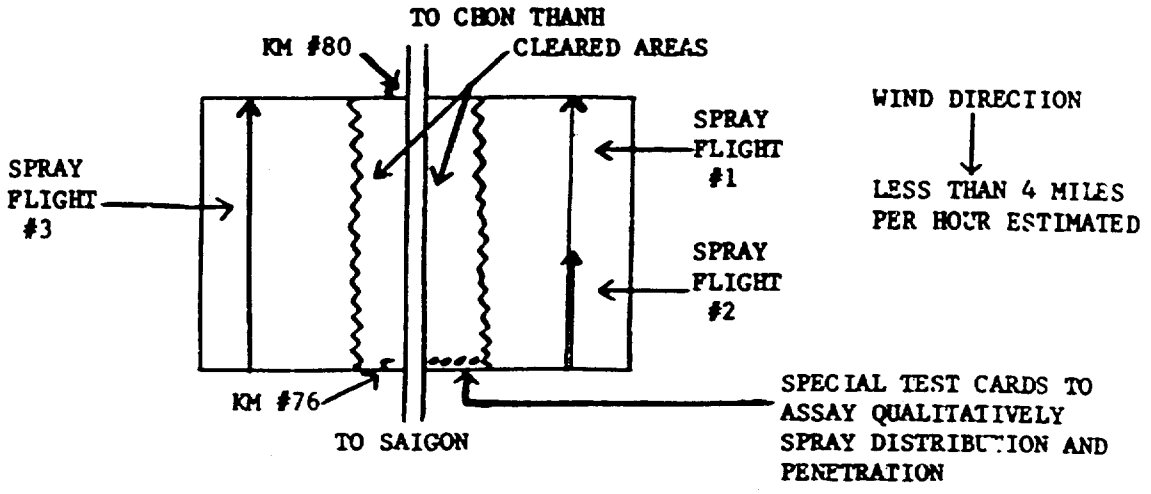
INFORMAL PROGRESS REPORT

TASK 20

C-47 Spray Rig

On Saturday, 19 August 1961, this rig was completely installed and functioned statically using water. Flow rates were checked. On Monday, 21 August the C-47 pilot (Lt TAM) was unavailable but the next day Captain Cadori flew with Lt TAM on 3 instructional spray flights. On Wednesday one additional instructional flight was performed using water for spraying and in preparation for the next day's operation, 200 gallons of Dinoxol were pumped into the spray tank.

Thursday, 24 August, the pre-selected roadside site in an area designated by President Diem was sprayed between 1030 and 1045 hours. Flights were inwind and actual spraying time totalled about 2 minutes and 45 seconds. The spraying was performed at an altitude of about 75 feet above the tree tops at 120 miles per hour. Under these conditions a swath width of about 300 feet is expected. A rough sketch of the test area with pertinent detail indicated is presented below. The total linear spray release, if converted from the test pattern indicated, would have been equivalent to a single swath of about 300 feet wide and about 5.5 miles long (about 8.8 km) covering a total area of about 196 acres (or close to 80 hectares).



Personnel Participating

VN

Capt Chan, Project officer, Task 20.
Lt Vo thanh Tam, Pilot of C-47.
Security Guards.

US

LtCol Langley, USAF
Capt Cadori, USAF, Pilot Advisor
T/Sgt Roe, USAF
Sgt McIntosh, USMC
Mr. Johnson, DA - CmlC
Dr. Brown, DA - CmlC, U.S. Advisor, Task 20.

Remarks and Recommendations

Preliminary effects of the spray should be recognizable within a 10-day to 2-week period on those species sensitive to the chemical spray. The test cards indicated good spray coverage. Most of the area was sprayed with a rate of 1 gallon of chemical per acre and a portion of the area intentionally received a rate of 2 gallons per acre. If later observation reveals essentially no difference in effect from these different rates of spray, it may be concluded that the rate of one gallon per acre is sufficient. Aerial observation of the area 4 days after spraying revealed little effect, however a marked effect is expected only after 10 days or 2 weeks on those species sensitive to the chemical spray.

It is recommended that a new gasoline engine be obtained to replace the present one which powers the pump which applies pressure to the chemical thus forcing it through the nozzles on the spray boom.

Capt Chan deserves special acknowledgement for accomplishing the many arrangments which contributed directly to the timely completion of this mission.

Lt Tru is to be commended for his diligent supervision of the VNAF technicians in the installation of the spray systems.

AD-6 and 14B Tank

The fabrication of wiring and preparatfons for a static functional test for one 14B were completed on 23 August 1961. A one day delay was encountered when a third high pressure compressor failed so that the functional test was made on 24 August. Flow rate adjustments were made using water and the tank was set to deliver 85 gallons in 21 seconds or about 4 gallons per second.

The most effective chemical presently known to kill mangrove is an ester of 2,4-dichlorophenoxyacetic acid at about 4 pounds per acre. Dinoxol is a mix of equal parts of the above compound and an ester of 2,4,5- trichlorophenoxyacetic acid. Two pounds of each compound are contained in each gallon. Thus in order to obtain 4 pounds of the former chemical per acre, 2 gallons of Dinoxol would be required per acre. Calculations indicated that this rate of deposit could be achieved in about a 300 foot swath by flying at 75 feet above the trees at 175 knots for about 1.2 miles.

On 25 August three sites were selected for aerial observation and viewed from the air by the AD-6 pilot, Capt Chan, Sgt McIntosh, and Dr. Brown. A single site was selected by Capt Chan and the pilot was briefed on the mission. The spray operation was executed at about 1040 hours and observed from a VN C-45 aircraft.

A noticeable effect on the mangrove area is expected to be obvious in about 10 days to two weeks.

Personnel Participating

VN

Capt Chan, Project Officer, Task 20.
Lt. Pham Phu Quoc, Pilot of AD-6.
, Pilot of C-45.
VNAF work force at hangar under supervision of Lt Tru

US

Sgt McIntosh, USMC
Mr. Johnson, DA, CmlC
Dr. Brown, DA, CmlC, U.S. Advisor, Task 20.

Remarks and Recommendations

This system was incorporated into the program of Task 20 for test and for demonstration purposes only. It was provided strictly on a loan basis and having served its purpose should be returned.

Sgt. McIntosh is to be highly commended for his heroic enceavors to prepare even a single 14B for reliable functioning. He was plagued from the start by missing parts, obsolete wiring instructions and a host of other bottlenecks beyond his control. His initiative and perseverance alone prevented cancellation of this system for test.

Capt Chan's performance was outstanding in completing the necessary arrangements for this test on extremely short notice while at the same time being heavily involved in the complex preparations for the C-47 test which was executed the day before.

Buffalo Turbine

This device was made ready a week or two ago as a spare time activity when delays were encountered on installing the C-47 and AD-6 systems. Having a lower priority, no roadside test site has yet been designated for its test. It is expected that early next week a test can be made.

TASK 2

H-34 with HIDAL Spray Rig

An inspection trip was made 28 August to observe effect of test sprays (Tasks 2 and 20) accomplished on 10 August north of Kontum. The landing strip at Kontum was closed and therefore ground observation of the sprayed areas was not possible. The roadside area that had been sprayed was visible from several miles away. The effect of the spray on the vegetation will continue to increase somewhat with time. The area sprayed agreed remarkably well with the map marked originally by the Province Chief of Kontum. There did not appear to be any overlap of sprayed areas as was originally intended. The trees and vegetation sprayed appeared to be about 75% susceptible. Density of the vegetation at the time of spraying may have prevented sufficient penetration of the spray. When observation of the area is possible on the ground this area can be evaluated further as to the desirability of respraying.

Little can be said of the manioc spraying until ground observation is possible.

Additional Proposals

1. Test the effectiveness of chemical sprays to reduce grassy vegetation prevalent in outpost areas and in ammunition depots to reduce concealment opportunities and fire hazard respectively. Depending on the areas involved it would appear that the helicopter spray rig could serve a useful purpose here.

2. Obtain 10 to 20 knapsack sprayers for test by troops using chemical sprays, such as Trinoxol to destroy manioc plantings encountered during their missions in VC dominated areas. It is suggested that these sprayers have a capacity no greater than 3 gallons. An additional supply of Trinoxol already requested will be required.

3. H-34's equipped with HIDAL spray rigs be temporarily based within operational areas. With fighter/bomber support aircraft the H-34's could begin test sprayings of manioc available to the VC.

/s/ J. W. Brown
U.S. Advisor
Tasks 2 and 20

SECTION XII

NOTES FOR COLONEL CHILSON, TASKS 2 & 20 — 16 October 1961

1. Below are listed a summary of my observations, as factual and as objective as I can make them, prefaced by a brief background statement.

2. After "seeking the truth" for 17 years (3 years with the U.S. Department of Agriculture and 14 years with the U.S. Army) in research concerning plant growth-regulating chemicals, primarily growth inhibitors, I was given approximately 10 days notice to come to Vietnam to undertake "research" in connection with the above tasks with what equipment and chemicals that were immediately available, despite the fact that for the past 4 years only a token effort in research applicable to Task 2 and for Task 20 no effort at all has been supported by the United States Army.

3. The chemicals used here for tests have been commercial concentrates (about 40% or less active ingredient) which were the best immediately available but marketed in this form for private and industrial (not military) use. Requested chemicals are 100% active ingredient.

4. The equipment employed for dissemination of these chemicals was designed for other primary uses.

5. No previous research has been undertaken in the United States or elsewhere for achieving the mission of Task 20 for the array of unknown (literally) species encountered in South Vietnam. (Recall the purpose and results of my trip to Singapore - 3 people for 6 months, 14,000 collections and perhaps 50 collections could be classified as to genus, the rest will only have numbers for identification for several years.)

6. Short of nuclear fission or nuclear fusion, efforts by man have been singularly unsuccessful in burning lush green vegetation on a large scale. Military efforts in the past have from time to time included the use of high octane fuels, diesel fuel or napalm separately or in concert and will undoubtedly be tried again in the future on a limited scale.

7. Added to the information in paras 2, 3, 4, and 5, trying to conduct tests in a country where terrorist activity cannot be ignored, periodic observations are at best either difficult to make or are impossible. However, if nothing is tried the status quo will never be improved.

8. The most successful tests in both tasks were not available to be observed until two months after treatment despite repeated efforts to observe them. When it was possible to observe them about half the trees had been chopped down for about one month (Task 20) and food plants (Task 2)

had been cut back within 6 days after spraying to prevent total destruction and loss. Another crop (rice) was not only unintentionally sprayed but was so severely damaged that it is estimated it will yield less than 10% of normal - yet these chemicals were not the ones of choice or even recommended - others are known of far greater potency - but rice was not even originally included in Task 2 even though it is now so considered as a result of this "test."

9. In any of these test demonstrations, there is obviously a "best" time to observe them - the overall response is transient if 100% kill is not obtained - that is, growth occurs in those trees or other plants which are either not susceptible, not sprayed, or if sprayed received sub-lethal quantities of spray, or seeds and seedlings develop quickly to fill in areas released by the death or defoliation of trees.

10. One great difference (other than size of plants) between natural forests and food crops is that most of the time food crops are concentrated such as a field (or several square miles) of nothing but rice whereas forests usually have many kinds of trees present of varying degrees of sensitivity. Sometimes they are called "pure stands" which if susceptible, can show the closest thing to 100% effectiveness (such as the sugar maple shown in the Camp Drum defoliation movie).

11. So far the least impressive and most tests have been conducted with the C-47 spray rig. It appears the least penetration of foliage has been achieved with this equipment which could be due to droplet size, altitude of release and time of day as related to neutral, lapse or inversion conditions prevailing or a combination of these factors. The equipment has been flown as low and as slow, consonant with safety, but yet at the maximum flow rate - so there is little latitude for adjustment other than replacing with nozzles we do not have on hand.

12. The Hourglass equipment was designed for large scale Task 2 work but which requires much lower rates of application for its intended use. It does, however, have a wide latitude for adjustment. So far aircraft have not been available to fly this equipment in Vietnam.

13. It is not even suggested that successful execution of Tasks 2 or 20 would "win the war" any more than the M-1 rifle, or a radio would, but it is sincerely believed the potential of this contribution could provide a means of doing some jobs more efficiently than can otherwise be done. No one appreciates food or visibility more than those deprived of it.

J. W. BROWN

SECTION XIII

TRIP REPORT - SOUTH VIETNAM (U)*

Dr. J. W. Brown
Deputy Chief, Crops Division
Fort Detrick, Maryland

(C) The writer was on TDY in South (Free) Vietnam at the request of the Advanced Research Projects Agency (ARPA) as the U. S. Advisor for Tasks 2 and 20 at the Combat Development Test Center (CDTC) for the period 17 July to 14 November 1961. This Center had been newly established in June 1961 and was a joint Vietnamese (VN) U. S. effort. The U. S. side of the Center (designated MAGRD) was responsive to both the Military Assistance Advisory Group (MAAG) and to ARPA.

(C) The writer was accompanied and assisted by Mr. W. B. Johnson, Crops Division, until 12 September. Because of the changing phase of the work, Mr. L. W. Boyer, Crops Division, was requested to assist and he arrived on 10 October. He is still in Vietnam and has been extended on TDY for an additional 60 days. The writer is presently scheduled to return to Vietnam 12 December on ARPA orders.

(U) During the course of the work the following personnel were on TDY to assist and are deserving of official recognition for their outstanding and unstinting efforts:

Mr. Boyer, Crops Division

Mr. Johnson, Crops Division

Capt. Mario C. Cadori, USAF, AO 936686
6053 Radio Fleet Mobile, APO 970, San Francisco

Sgt. James McIntosh, USMC Ser. #1458 1458594 MOS 6511
1748 Central Ave., Middletown, Ohio (believed to be presently assigned at Cherry Point)

I/Sgt. Leon O. Roe, USAF, AF 6969313
4500th Ops. Squadron, Langley AFB, Virginia

Each of these men achieved the respect and friendship of the Vietnamese with whom they worked and in their associations were thus able to transmit to the Vietnamese a know-how in their various specialties.

---

* December 1961.

(U) The immediate assistance of Dr. Charles E. Minarik, Chief, Crops Division, on the "home front" was a source of amazement to others at the Center. His appreciation of the problems encountered and his direct handling of requests for essential information and equipment were and are deeply appreciated.

(C) It is impossible to name all of the Vietnamese and U. S. personnel with whom the writer worked or held discussions relative to the work but some are listed below who have been directly involved:

VN
- President Diem
- Mr. Nhu, Assistant to the President
- Mr. Thuan, Secretary to the President
  - Secretary of Defense
  - Secretary of State
  - Secretary of Security
- Mr. Van, Assistant Secretary for Dept. of Rural Affairs
- Maj. Gen. Minh
- Col. Trach, CO, CDTC
- Capt. Chan, Project Officer Tasks 2 and 20
- Capt. Khoat, Administrative Officer CDTC
- Lt. Col. Tri, Division CO, Kontum Area

US (in Vietnam)
- General Maxwell Taylor
- Dr. Walt W. Rostow
- Dr. George Rathgens, Dep. Director of ARPA
- Mr. William Godel, Dep. Director of ARPA
- Ambassador Nolting
- Lt. Gen. McGarr, Chief, MAAG
- Maj. Gen. Timmes
- Brig. Gen. Eggleston
- Col. Chilson, Chief MAGRD
- Lt. Col. Langley, Dep. Chief, MAGRD

(C) Upon returning to the U. S. on 15 November discussions and briefings have been held with the following people:

- General Maxwell Taylor
- Dr. Walt W. Rostow
- Dr. James Hartgering
- Dr. Macrae
- Dr. Corey
- Dr. Sheehan
- Mr. William Godel
- Lt. Gen. Trudeau
- Undersecretary of State, U. Alexis Johnson and Staff

(C) Attached (Incl 1) is a review of the work which, in its original form, was prepared for and given to General Maxwell Taylor's group on their departure from Vietnam. It has been retyped and has received minor corrections. The writer accompanied General Taylor and his party during a 2-day aerial tour of the country.

(C) Attached (Incl 2) is a schedule of sprays and observations made.

(S) Very strict security precautions were observed throughout the period of work. The VN were very quickly impressed by the potential disclosed to them by these demonstrations and consider these efforts TOI MAT (IS) despite a secret classification considered in the U. S. to be adequate. Premature disclosure to the press of this information would seriously jeopardize past and future work in Vietnam. The terrorists (VC) have made efforts to obtain information concerning these chemical sprays directed against vegetation but so far Radio Hanoi, although freely making accusations, has been largely on a "fishing" expedition.

REVIEW AND EVALUATION
TASKS 2 AND 20
October 1961

(S) The objectives of these two tasks originally were to provide a demonstration of the feasibility of:

(Task 2) Destroying manioc (tapioca) by a chemical spray to deny food to the VC and

(Task 20) Killing trees along the western border of South Vietnam with a chemical spray to improve visibility to aid in observing enemy movements, also spraying certain roadside areas to aid in preventing ambush.

(S) These objectives were to be accomplished with materials and equipment which were immediately available - a controlling limitation. Thus, commercially available preparations (containing only 40% active ingredients) were obtained and equipment primarily designed for other purposes was requested because of its availability, not because it had been tested or used for work of this kind before.

(S) Task 2 was enlarged shortly after the arrival of two U. S. advisors by including sweet potatoes. After the demonstration for this task was performed, rice, which had not been intentionally sprayed, was also included.

(S) Task 20 was enlarged as well but primarily in terms of areas to be sprayed, e.g., the killing of vegetation in Zone D and adjacent area near the western border. Mangrove was included as a species for destruction in delta areas.

(S) To accomplish these enlarged scopes ordinarily under peaceful conditions would require a research team of 10 to 20 and at least 2 growing seasons at as many sites as appropriate for the specific kinds of vegetation, not including test screening of as yet untested compounds for improved efficiency.

(S) It is worthy of note that not one U. S. Military dollar has been spent for research for a defoliant during FY 58, 59, 60 or 61 even though a U. S. military requirement was existent. The staff for anticrop warfare was cut from a force of about 125 to 12 during FY 58 and currently only about 16 professionals are employed for all aspects of this program, only one of these is on the payroll specifically for anticrop chemicals.

(U) Thus, a large order was placed on a very poorly supported research effort.

Encl 1

(S) Most species encountered in Vietnam in jungle and roadside area tests have probably been sprayed for the first time in history in the past 2 to 3 months. Many of the species encountered are literally unknown to botanical science.

(S) During the development of the spray effect, more than once trees have been chopped down and test plants have been cut back or destroyed as in the vicinity of Kontum and at ARVN Hq. without the writer's knowledge or permission.

(S) Perhaps the best equipment, the H-34 HIDAL spray rig, for small area coverage (e.g., manioc and sweet potatoes - Task 2) was functioned for test only once because damage to the aircraft was encountered and the spray equipment was grounded. It is still grounded despite urgent TWX's to expedite a fix. The tests with this equipment were so successful that they evoked an unsolicited enthusiastic message which came from Kontum Province. A sizeable VC operation in the area prevented ground observation because of security until two months after spraying. The effect was pronounced (Prints of these negatives have been requested to be sent to General Taylor at his home office). The villagers with whom arrangements had been made by the VN to reimburse them for damages, became so alarmed at the prospect of losing their main staples of diet, manioc and upland rice, that they petitioned for relief after one week and they topped the manioc plants to prevent greater damage to this root crop. At the time of ground observation 2 months after spraying it was estimated that about 50% of their root crop had rotted and 80 to 90% of their sprayed rice would be lost.

(S) It is extremely difficult to make an overall estimate of effect on the "Kontum" roadside spray because of the clearing operation which started there one month after spraying. There were trees still standing which had no leaves at all as a result of the spray, some seemed to have retained all their leaves but they were all brown and shrivelled and there were some which appeared entirely untouched. The clearing operation was not complete at this time and there is no way of knowing whether the more severely affected trees were selected for cutting or not. It would, however, seem probable that, other things being equal, the wood removed from the site for fuel or other purposes could possibly have been mainly from the most denuded trees. These would be the most easily trimmed out and the driest. Considering all these factors, my estimate is that the single spray was about 70% effective. Others have seen the area at the same time and may choose to enter their estimates - among them are Col. Trach, Lt. Col. Langley, Lt. Col. Dalby, Maj. Jackson and Mr. Boyer and the Deputy Province Chief of Kontum. It is not known whether Col. Woolfolk - senior advisor at Kontum has seen it more frequently or not - however, he made the remark to me that "we sure could use a lot of that stuff!" Lt. Col. Tri, Division CO in the area remarked that he thought the chemical was good but the method of dissemination could be improved. He is anxious to have chemical and knapsack sprayers for test by his soldiers when they come across areas cropped in the mountains or jungle and under the control of the VC.

(S) There have been the following basic tests performed:

1. (S) 10 August 1961 - Tasks 2 and 20

Roadside spray (Task 20) north of Kontum on the road to Dak To. Chemical - DINOXOL ± 1 gallon or 4 pounds per acre.

Manioc and rice (Task 2) near a small hillside village in the vicinity of Dak To. Chemical - TRINOXOL ± 1 gallon or 4 pounds per acre.

Only two observations were possible, one on overflight on 28 August, the other a ground observation on 11 October.

Equipment Used. H-34 helicopter rigged with HIDAL spray rig. Capacity 200 gallons used once and subsequently grounded because vibration cracked fuselage of H-34 when flown at speeds up to 80 knots on the way from Saigon to Kontum. A fix has been urgently requested. Very good test results were obtained using this equipment.

Results

Task 2. Very good to excellent. The possibility exists that rice may be burned 3 days to 1 week after spraying, but this has not been tested. It was reported dead 2 days after unintentional spraying. Top kill was achieved which is estimated to cause up to 90% yield reduction. Weights (and samples) of cleaned but not pounded grain have been requested from sprayed and unsprayed equal size plots at harvest.

Task 20. Roadside clearing of trees starting about one month after spraying and too infrequent observation prevents an unequivocal evaluation. However, a guess would be about 70% effective in killing the dominant trees at this site.

2. (S) 11 August 1961 - Task 2

(This is included for the record.)

a. Sweet potato plants, manioc, and a banana tree as well as native grasses and weeds encountered behind the VN guest house of the Kontum Province Chief were sprayed with TRINOXOL from a 3 gallon portable garden sprayer.

b. Bamboo and manioc were sprayed in the MAAG BOQ compound at Kontum as above.

Results

a. The food plants were observed to be sensitive to the spray within one hour. On 11 October only empty space remained where the plants had been.

b. Pictures before and 1 day after spraying were made. On the second day the plants had been cut down by a native living on the other side of the fence.

3. (S) 24 August 1961 - Task 20

Roadside spray near Chon Thanh. Chemical - DINOXOL - 1 gallon or 4 pounds per acre on both sides of the road plus part of east side was resprayed to obtain a rate of 8 pounds per acre. These quantities were released but the altitude was closer to 125 feet than the 75 feet requested. Time of day was 1030 to 1045 with a wind about 10 degrees off of head wind at about 5 to 7 knots.

Equipment Used. C-47 spray rig used in the States for mosquito control was used here for first time. Ran at maximum flow rate, 73 gallon per minute, airspeed 120 mph. Pump at maximum ± 30 pounds. B-10 nozzles. Particle size small.

Questionable test results were obtained at this site. Total of Km linear distance sprayed but only 8 covered on ground, ± 2 Km got entional repeat dose. Swath estimate at 300 feet.

Results. All observations subsequent to spraying have been by flyovers. This area has had frequent VC activity. The first observation on 28 August was too early for any real effect; again on 7 September, when swaths were clearly defined but weather was cloudy. Pictures were taken anyway. Small particle size showed evidence of considerable drift on west side - missed intended swath by about 300 feet. Decision to respray next day to put swath in place. Much lower altitude estimated at less than 50 feet abc trees. Observed prop wash caused spiraling turbulence of spray from wi ounted booms and particle size so small that it had little tenden settle. Dosage either too small as a resul, or species showing some stance. Little evidence of increased effect from intended double dose or initial spraying. This was so unexpected after Kontum observation - that is, little overall effect initially plus little increased effect from double dose made doubtful a strong species resistance theory and lends more credence to small particle size causing dissipation of intended dose. (See other tests below with C-47 equipment.)

4. (S) 25 August 1961 - Task 20

Mangrove spray SE of Saigon on line with Cap St. Jacques. Chemical - DINOXOL. Because DINOXOL contains 2 pounds each of 2,4-D and 2,4,5-T esters (butoxy ethanol) per gallon and 2,4-D is agent of choice for mangrove it was decided to spray at a rate of 2 gallons per acre in order 4 pounds 2,4-D per acre. Pilot flew at altitude of about 75 feet initially but climbed to about 100 feet while spraying at 178 knots - 85 gallons released in 20 seconds.

Equipment Used. AD-6 aircraft with one loaded 14B spray tank. This tank has a classified component and was loaned for demonstration test only. Two tanks were sent but had so many missing parts and accessory gear that two separate airlifts were required. After all this trouble and delay only one could be made functional by the USMC EM specialist despite his heroic and unstinting efforts. These tanks were originally intended to be the first item operational with only some modified wiring required. However, almost three weeks went by before word was received from Washington recognizing a change in the wiring modification. The system was retained in the schedule only because of this man's desperate desire to make this tank function.

Results. Where the altitude of release was about 75 feet the effect was greatest and diminished along the flight path as the altitude increased. The release was made on a crosswind flight and there is evidence of the effect tapering off downwind as the dose became sub-lethal. This particular swath is the most impressive in the mangrove area at this writing. Aerial observations have been the only kind possible in this swampy area. Flyovers were made on 7 and 20 September and 15, 20, and 24 October and tests 5 and 6 were observed also on these dates as they came into being.

5. (S) 13 September 1961 - Task 20

Mangrove spray in area of test paragraph 4 above. Chemical - "Concentrate 48" - ethyl ester of 2,4-D - water dilutable formulation where chemicals previously mentioned are oil dilutable. Three pounds active ingredient per gallon. 2,4-D formulations have been indicated by British and U. S. investigations previously as being 2 to 4 more times effective on mangrove than 2,4,5-T formulations. An effort was made to release 3 and 6 pounds per acre rates. Time of day - 1015.

Equipment Used. C-47 Spray rig. Seventy-five foot altitude requested, 120 mph to obtain 1 gallon per acre with partial repeat swath for higher rate.

Results. Indications are that sub-lethal rates were deposited indicating particle size so small that dissipation of release was excessive. Striking "fall coloration" was observed in isolated trees - indicative of sensitivity of these particular unknown species.

6. (S) 14 September 1961 - Task 20

Mangrove spray near area of tests 4 and 5 above. Single swath sprayed once and part sprayed twice with TRINOXOL - rate 4 and 8 pounds per acre.

Equipment Used. C-47 spray rig. Heading 240 degree. In-wind flights. Wind estimated 18 knots. Time 1045. Rain shower fell on area within 10-15 minutes after spraying.

Results. DINOXOL supplies were less than 50 gallons at this time and equipment below (Test 7) had not been functioned. However, TRINOXOL being oil-dilutable was of interest for effect and comparison with other chemicals on same type of vegetation. Indications are that this formulation is second best on mangrove compared to the effect of DINOXOL delivered by the 14B tank and AD-6. It withstood the effects of a hard downpour shortly after spraying, indicating the desirability of oil-based formulations over those prepared for water dilution. At this date it was not possible to make a true comparison in all respects - the 14 B's had been dismantled - the DINOXOL supply was practically exhausted - the C-47 spray particle size and deposit characteristics had been indicated as leaving something to be desired if all-day operations were to be considered.

7. (S) 18 September 1961 - Tasks 2 & 20

Many native trees and grasses were sprayed with DINOXOL near ARVN CDTC building. Because of its location and lack of a security problem this site was observed on the ground with a frequency not possible with more remote sites. However, because of the soggy terrain it was not always possible to maintain a steady ground speed of 10 mph, with the equipment. In fact, during delivery of the spray the rig and towing jeep had to be towed free from hub-deep mud. There is, however, an instant on-off valve which was manned constantly by a technician.

Equipment Used. Buffalo Turbine towed by a jeep. Although primarily used for orchard sprays, it is believed a useful item for roadside sprays using jeep or a light truck for towing it. It has a single axle on which is mounted a gasoline engine operating a pump and a turbine for producing a useful mean particle size which can be directed up to 125 feet in a calm, open area.

Results. One day after spraying extreme responses were noted in a majority of native trees, shrubs and grasses at this site. The results were very impressive. Many species were not directly sprayed but upper air movement carried the spray over a 10-foot wall and caused severe effects in trees about ½ mile away. Many observations and photographs were made of portions of this area. Among identifiable species affected severely are banana, papaya, grape, maize and melons. Buffalo grass presents a fire hazard around ammunition depots, buildings, etc., in Vietnam. Within a week it was tested at this site for burning and without due precautions could have caused a large scale fire even though ½ hour after spraying a continuous heavy rain lasted for 16 hours. Burnability is greatly affected by the prevailing humidity so that if this means is considered for disposing of sprayed vegetation during a rainy season, perhaps tests should be conducted during the late afternoon of a clear day. Leaves of bamboo (or a close relative) were layered on the ground under this vegetation about 10 days after spraying.

An unknown but very sensitive tree species was entirely defoliated in one week after spraying.

These results with ground equipment make it appear that much improvement in aerial dissemination equipment is possible and that many native species are sensitive to these chemicals.

(S) About the Chemicals. All chemicals used in these tests were commercial "concentrates" of about 40% active ingredients, specially prepared so that their effect is restricted essentially to that vegetation receiving only a direct spray. It is possible to obtain these liquid chemicals of virtually 100% activity with a volatility characteristic (butyl esters) which give an added effectiveness. These are the kinds of chemicals requested for large scale area use.

(C) These chemicals are known as herbicides or plant growth-regulating chemicals and in 1960 about 40 to 50 million pounds were produced commercially in the U. S.

(U) There are stringent state laws in the U. S. concerning the aerial spray of these chemicals to prevent damage to areas not intended to be exposed as well as regarding the indiscriminate use of the more volatile forms.

(U) DINOXOL is a 50-50 mixture of the butoxyethanol esters of 2,4-dichlorophenoxyacetic acid and 2,4,5-trichlorophenoxyacetic acid, 2 pounds of each per gallon.

(U) TRINOXOL is the latter chemical only at 4 pounds per gallon. One gallon of each of these commercial formulations weighs 9 to 10 pounds.

(U) These two products are oil-based preparations.

(S) "Concentrate 48" contains 3 pounds per gallon of the ethyl ester of 2,4-D. It is a water dilutable preparation which was substituted for an oil based isopropyl ester of 2,4-D for use on mangrove. 2,4-D products are agents indicated in the U. S. for spraying coniferous species such as pines and cedars.

(S) Stocks on hand here presently are:

DINOXOL - about 25 gallons
TRINOXOL - about 150 gallons
Concentrate 48 - 400 gallons

(S) About 15 potential chemicals ranging from pound or gallon quantities to a few grams are on hand for micro tests on native species but the pressure of work has prevented this experimentation.

(S) Cacodylic acid is a solid which has a relatively high water solubility (± 40 to 45%) and which has shown striking results when sprayed on rice at certain stages of development at 0.25 pounds per acre. However, the harvest time for upland rice is now believed too near to expect to use this chemical this year to destroy rice. TRINOXOL at 4 to 8 pounds per acre performed sufficiently to top kill rice during the rainy season so that burning during the rainy season should receive consideration.

(S) Contemplated Areas for Spray in Vietnam

1. D Zone and adjacent border area (perimeter and trails) estimated area 100 square miles. Chemical recommended: 50-50 mix of pure butyl esters of 2,4-D and 2,4,5-T. At one gallon per acre, 64,000 gallons are required. Since a gallon weighs 11 pounds, total weight of chemicals will be 705,000 pounds.

Chemicals at $1.25/lb	$900,000
Airlift, at $1/lb	705,000
Airlift for drums (50 lb each) at $1/lb	64,000
For chemicals in VN	$1,700,000

2. Border: 900 miles x ½ mile wide = 225 square miles. 2.25 x $1.7 million = $3.9 million.

3. Mangrove (area unknown): for 100 square miles see estimate for 1. above ($1.7 million). Chemical: pure butyl 2,4-D.

4. Roadside: 900 miles x ½ mile wide = 225 square miles. 2.25 x $1.7 million = $3.9 million.

5. Manioc and/or rice (area unknown): per 100 square miles see 1. above. Applicable for rice only if sprayed about one month ahead of harvest. Chemical: pure butyl 2,4,5-T. Cost: $1.7 million.

These estimates are rough but total far less than $75 million, the first estimate received. An honest error in arithmetic may have crept in between the source and destination. Or, alternately, the communication system in this instance is precarious and might be amenable to allowing a useful tool to be priced out of consideration.

Miscellaneous

(S) The installation of the various systems would have been unduly prolonged had it not been for the very prompt response of VN Captain Le-Minh Chan in making necessary arrangements. The U. S. advisors arrived on 17 July and during the following 24 days equipment to be installed arrived essentially

on a piece-meal basis. The HIDAL equipment was used for the first test on the 24th day simply because it was the first unit completely on hand. On the 38th and 39th days the C-47 and AD-6 systems were functional.

(C) These things were accomplished despite the following difficulties:

1. The language barrier - and attendant lack of communication.

2. Lack of telephones, transportation, adequate secretarial help (1 man) and office facilities.

3. The preparation of too many reports while trying to do the physical job.

4. The frequent influx of visitors which caused delays.

5. The security problem in a country at war.

(S) Special mention is made of having to convince the local USAF personnel that special pilot instruction was mandatory for the VN pilots for spray missions. This was not agreed to until the U. S. Advisor for these tasks flatly refused to take the responsibility for their safety or that of the equipment which had been installed if the VN pilots were denied this instruction. In this connection it is recommended that the entire Special Air Spray Flight at Langley AFB, Virginia, be considered for assistance if the decision is made to scale up the spraying of chemicals here in Vietnam. In particular, Captain Cadori, USAF, and T/Sgt Roz, USAF, should be returned to Vietnam if this decision is made.

(S) The U. S. Advisor for Task 2 and 20 has been along on every spray mission except the first C-47 and the AD-6 mission. For the former he was on the ground on location and the latter was observing from a C-45. There is no doubt that this hazardous flying but showing the VN pilots that he had confidence in them by flying with them on these missions has been appreciated by them and cooperation thereby strengthened.

(C) Because communication between Vietnam and the States at times encounters serious delays, it is recommended that for quick technical answers regarding these Tasks, Dr. Charles E. Minarik, Chief, Crops Division, Fort Detrick, Maryland should be contacted. His telephone is MOnument 3-4111, Ext. 2202.

J. W. BROWN
Deputy Chief, Crops Division

[redacted] PAGE WAS BLANK, THEREFORE NOT FILMED.

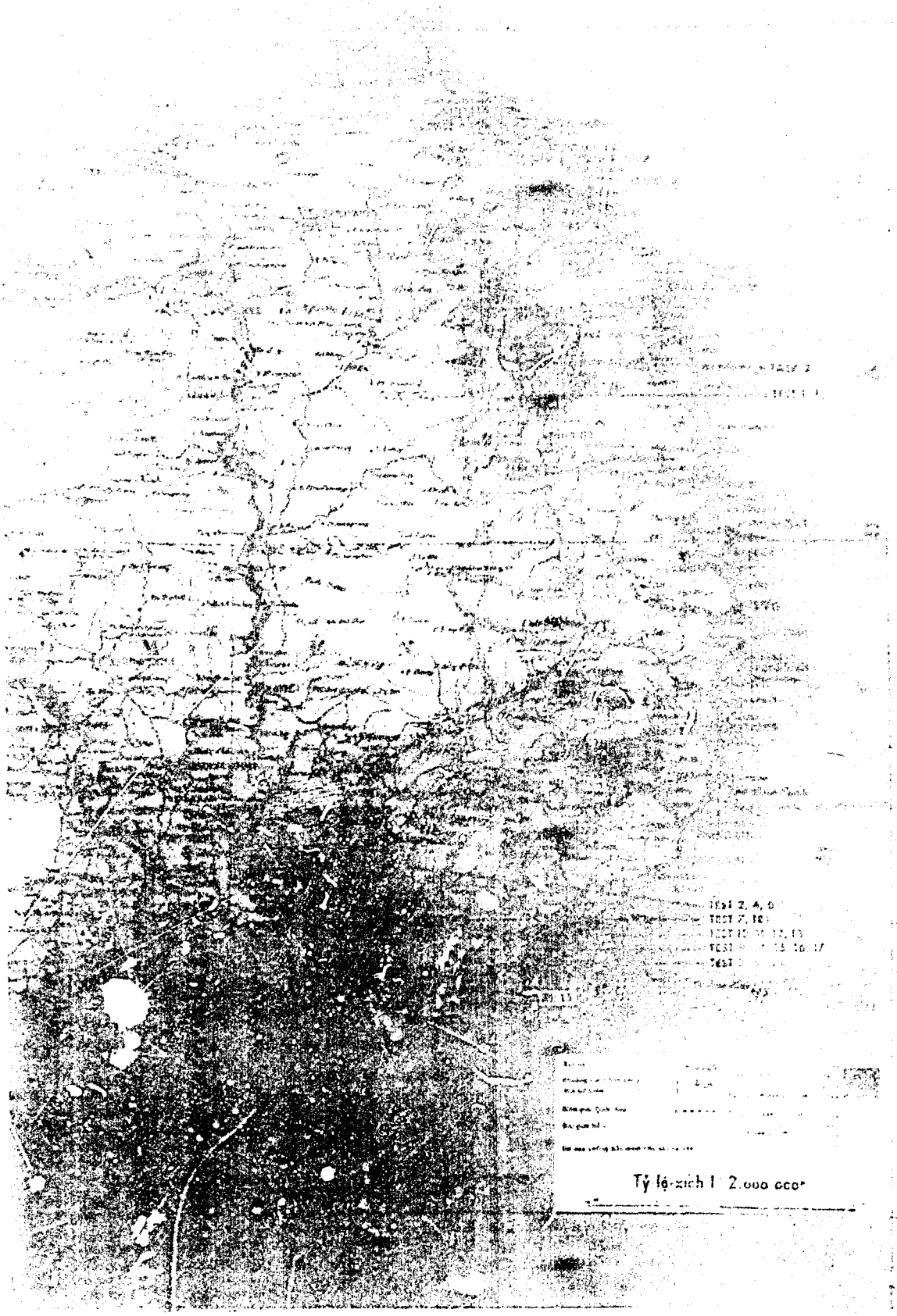
(C) SCHEDULE OF SPRAYS AND OBSERVATIONS MADE

SITE	AREA	SPRAYED	OBSERVATIONS
A	Kontum	10 Aug 61 - H-34 DINOXOL - 1650-1715	28 Aug 61 (Air) 11 Oct 61 (Ground)
	Dak To	10 Aug 61 - H-34 TRINOXOL - 1730-1745	28 Aug 61 (Air) 11 Oct 61 (Ground)
B	Chon Thanh	24 Aug 61 - C-47 DINOXOL, 1030-1045	8 Sept 61 (Air) 20 Sept 61 (Air)
		8 Sept 61 - C-47 DINOXOL - Touch-up on 8 Sept	
			16 Oct 61 (Air) 28 Oct 61 (Air) 31 Oct 61 (Air)
		17 Oct 61 - C-47 TRINOXOL - 0915-0930	
C	Mangrove	25 Aug 61 - AD-6 DINOXOL - 1030	7 Sept 61 (Air) 13 Sept 61 (Air) 14 Sept 61 (Air) 20 Sept 61 (Air)
		13 Sept - C-47 Conc. 48, 1015-1030	15 Oct 61 (Air) 24 Oct 61 (Air) 28 Oct 61 (Air)
		14 Sept - C-47 TRINOXOL, 1045-1100	31 Oct 61 (Air)
D	[redacted] Hq.	18 Sept 61 - Buffalo Turbine - DINOXOL - 1530-1630	19 Sept 61 (Ground) 21 Sept 61 (Ground) 25 Sept 61 (Ground) 26 Sept 61 (Ground) 27 Sept 61 (Ground) 12 Oct 61 (Ground) 2 Nov 61 (Ground)
E	Bien Hoa	17 Oct 61 - C-47 TRINOXOL, 0845-0900	20 Oct 61 (Air) 24 Oct 61 (Air) 28 Oct 61 (Air) 31 Oct 61 (Air) 7 Nov 61 (Air)

Incl 2

SECTION XIV

LOCATION OF VEGETATIONAL SPRAY TEST SITES


Tỷ lệ xích 1: 2.000 000

SECTION XV

MAGRD 29 January 1962

MEMORANDUM FOR: Chief, R&D Division, (MAAG, VN)

SUBJECT: Roadside and Jungle Spray

1. Following oral instructions from OSD/ARPA that, if for a valid technical reason, operational chemical spraying be stopped in South Vietnam, it would be incumbent upon me to so recommend.

2. I therefore recommend that this spraying be held in abeyance in those areas where the progress of the "dry" season (and other associated climatic factors) is such either to prevent vegetative growth entirely or to slow down vegetative growth to a marked degree. The very nature of the action of pink, green and purple materials is dependent upon the active growth of the trees and crops.

3. Spraying of these materials should begin again or continue only in those areas where vegetational growth is active and where, if the growth has been curtailed, it has been active again for a period (estimated) of three weeks or more. The nature of the vegetation over large expanses continues to appear green and lush, however, on close inspection on the ground in the target area along Route 15 on 26 January 1962 the indications were that most forest species were in a relatively dormant condition, that is, new shoots and leaves were not being formed. The only exceptions noted were sprouts from the stumps of trees which had been chopped down (it is estimated) on or about the first of January. The nature of growth of these sprouts revealed distortions and other growth responses peculiar to and characteristic of the chemical spray applied 13 January 1962 by C-123 aircraft.

4. Today, 29 Jan 1962, I met with Mr. Lam-Van-Thanh, Chief of Research, Department of Rural Development, who indicated that vegetative growth now is at a minimum for many forest species and that with the onset of the "rainy" season growth will resume in the majority of species. This "rainy" season, according to him, resumes in May and continues to October in the southern part of South Vietnam, tapering off thereafter. It would appear then that the optimal time for resuming spray operations would be late May or early June.

5. It is recommended that Vietnamese agricultural and forestry experts who have access to information throughout the intended areas of spray be selected and designated to advise on the selection of vegetation targets as related to the suitability of their condition of growth and to warn of desirable vegetation in the vicinity which should not be sprayed or receive spray drift or vapors.

6. It is recommended that the lag time enforced by seasonal change be utilized to calibrate the C-123 (and H-34, too, if convenient) spray equipment with the purple material. Capt. Frank Dowell, USAF, 2nd ADVON, is cognizant of this need for the C-123 equipment while Cdr. George S. Stains, Disease Vector Control Center, NAS, Jacksonville, Florida is most familiar with the HIDAL equipment. The viscosity of the purple material is significantly greater than materials previously used in these systems and for which these systems were calibrated. Its viscosity should be checked for a range of operating temperatures as well. The H-34 HIDAL should be checked as well for the pink (rapidly fading to white on the drums) material as well, if its viscosity differs appreciably from that of the purple. The ultimate aim, of course, is to gain as much assurance as possible that the particle size spectrum is suitable for optimal penetration and impaction of foliage encountered in target areas here; also that the flow rates (consistent with altitude, airspeed, swath width, etc.) are adequate to provide a deposition rate necessary to achieve optimal effect.

7. Capt. Dowell has informed me that during February (as I recall - he can verify) atmospheric conditions undergo a change which may become a limiting factor in achieving satisfactory spray deposition.

8. It should be noted:

a. U.S. military research in these areas was essentially unfunded for four years prior to my coming to Vietnam.

b. When I came on short notice in July that:

(1) Only materials and equipment immediately available were to be utilized;

(2) Time of action of the materials for effect was not critical;

(3) A universal "defoliant" remained and remains yet to be discovered.

c. Since I arrived in Vietnam an old chemical (coded blue) was discovered at relatively low rates to have defoliating properties in the U.S. on cotton. It is still on an experimental use basis in the U.S. for cotton defoliation by the manufacturers. A test jungle swath was sprayed with this material on 12 Jan 1962 from an H-34 (because it has a fibreglass tank and stainless steel spray boom - the material was known to have some corrosive properties) and the results in one week were very impressive, it appears to be a relatively quick acting desiccant at the rate used. Other questions regarding length of time required for detoxification of the material or of residual effect could and should be studied in the U.S. before unlimited jungle application is pursued in Vietnam. Use rates for this type of aerial spray should be refined as well and these, too, could perhaps be more efficiently determined elsewhere. Native grasses at the Navy Yard, Saigon, were sprayed as well 12 Jan 1962 on the same spray mission and burned on 22 Jan 1962 (Ref: Lt. Col. Brown, USMC, MAAG, Advisor to VN Marine Commandant).

d. Efforts to get a C-123 here ahead of time were unsuccessful.

e. In my experience here, spray effects have been most impressive using the HIDAL mounted on an H-34, but the capacity of this system is limited, and aircraft maintenance and vulnerability are relatively high.

f. Mr. Boyer plans to return to the U.S. early in February and as indicated to you two weeks ago I plan to return about mid-February.

/s/ J. W. Brown

SECTION XVI

RAINFALL MAPS

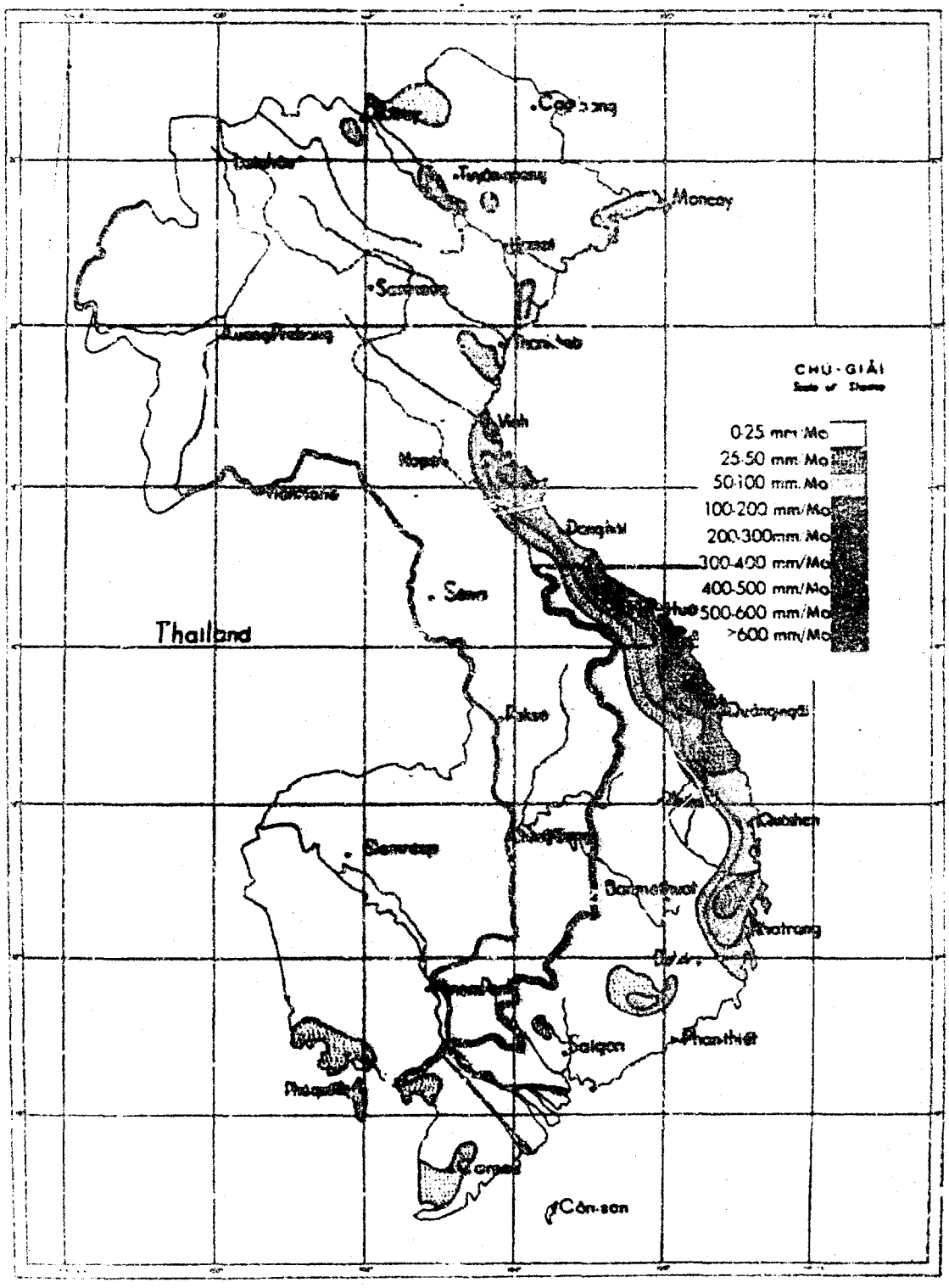
VIỆT-NAM CỘNG HÒA
NHA GIÁM-ĐỐC KHÍ-TƯỢNG
REPUBLIC OF VIETNAM
DIRECTION OF METEOROLOGY

THÁNG GIÊNG

CAO-ĐỘ MƯA TRUNG-BÌNH
tại VIỆT-NAM, AI-LAO và CAM-BỐT-GE

JANUARY

AVERAGE PRECIPITATION
in VIETNAM, LAOS and CAMBODIA



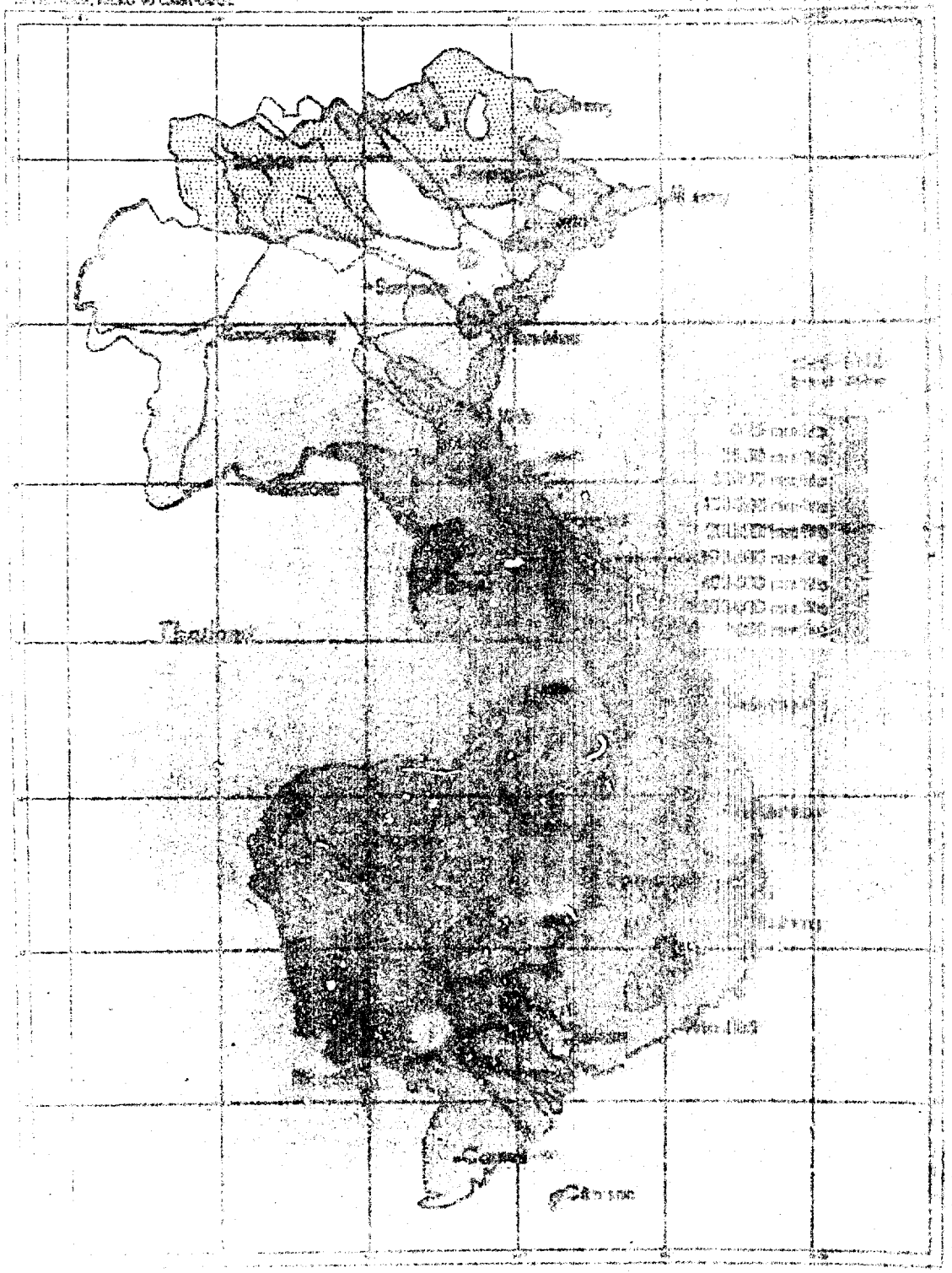
VIET NAM CỘNG HÒA
NHA KHÍ TƯỢNG VIỆT NAM

REPUBLIC OF VIETNAM
DIRECTION OF METEOROLOGY

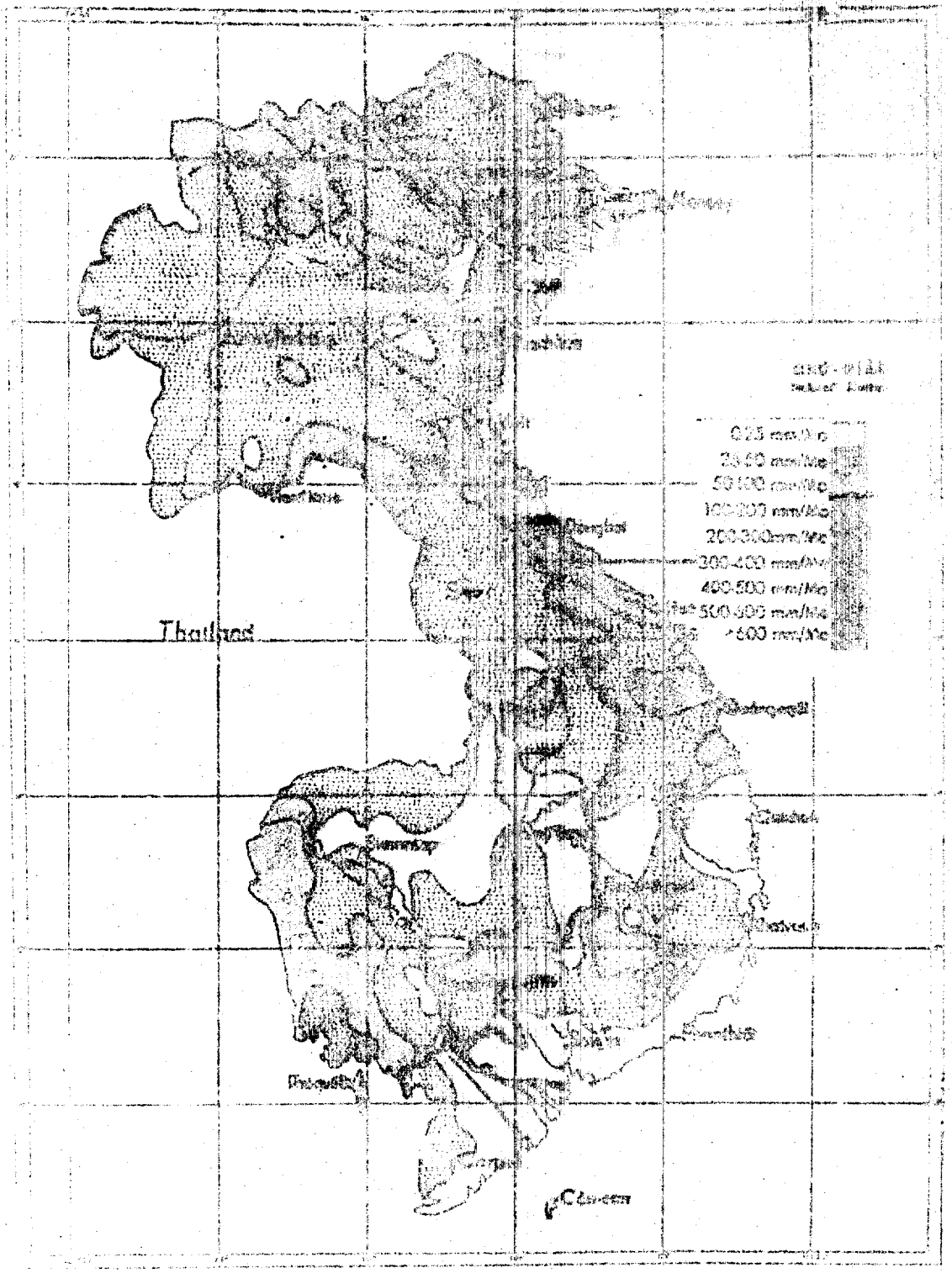
THÁNG MAI

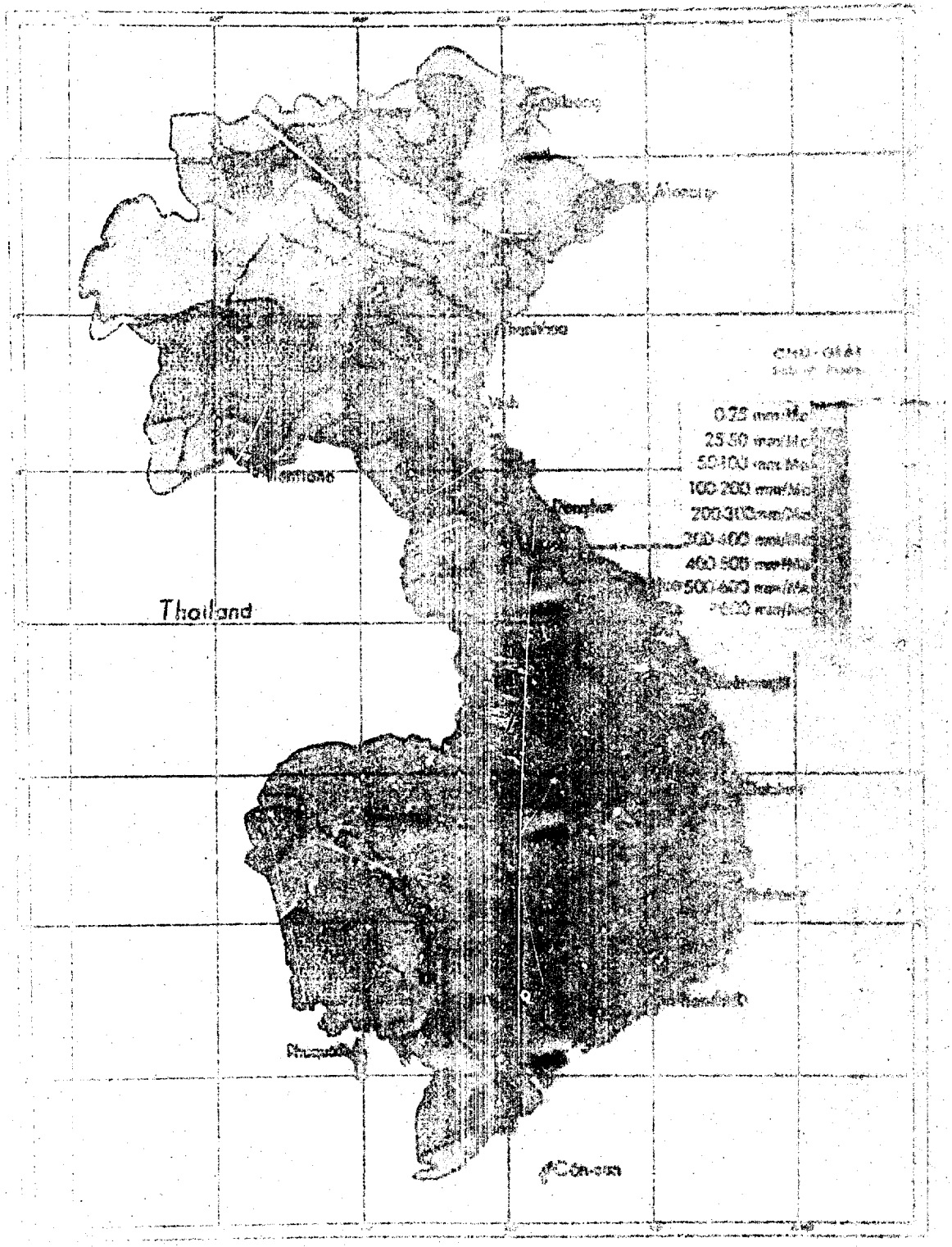
CẢ NƯỚC MÙA TRUNG BÌNH
OF VIETNAM, LAOS AND CAMBODGE

FEBRUARY



THÁNG 8A



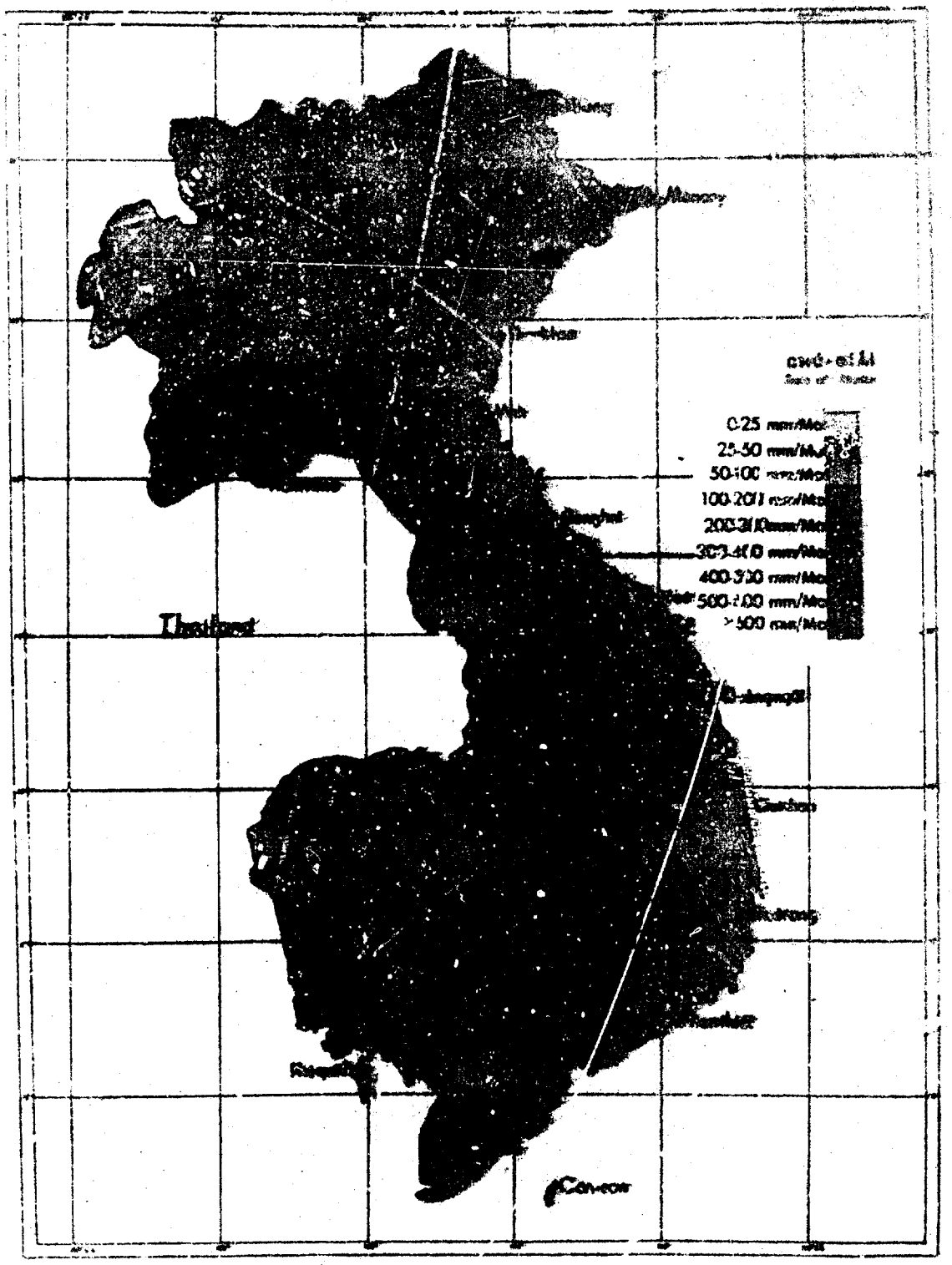

Thailand

THÁNG NĂM

CAO-ĐỘ MƯA TRUNG BÌNH
ở VIETNAM, LAOS và CAMBODGE

MAY

AVERAGE PRECIPITATION
in VIETNAM, LAOS and CAMBODIA



THÁNG SÁU

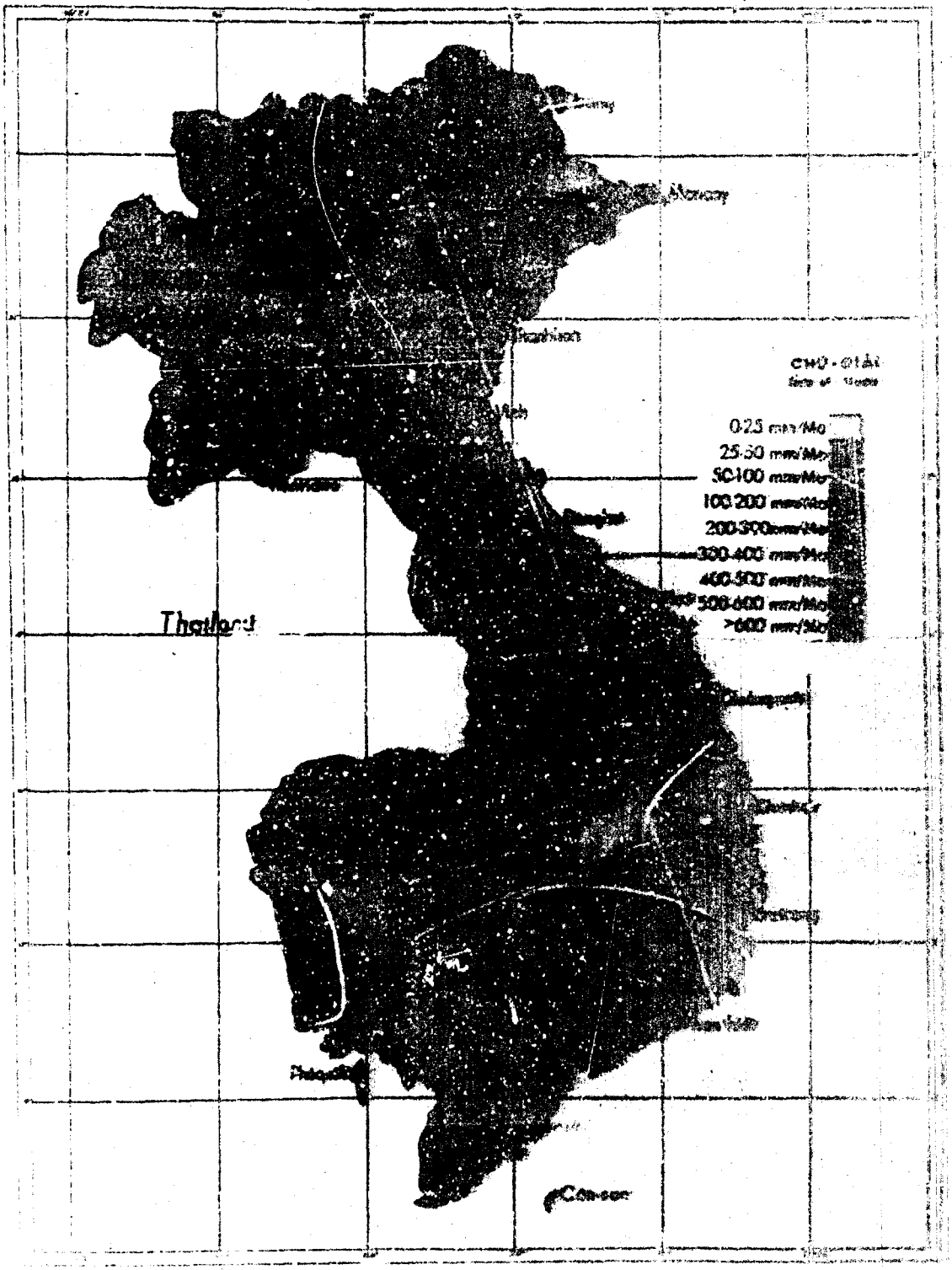
CAO-ĐỘ MƯA TRUNG BÌNH
ở VIỆTNAM, LÀO và CAMBODGE

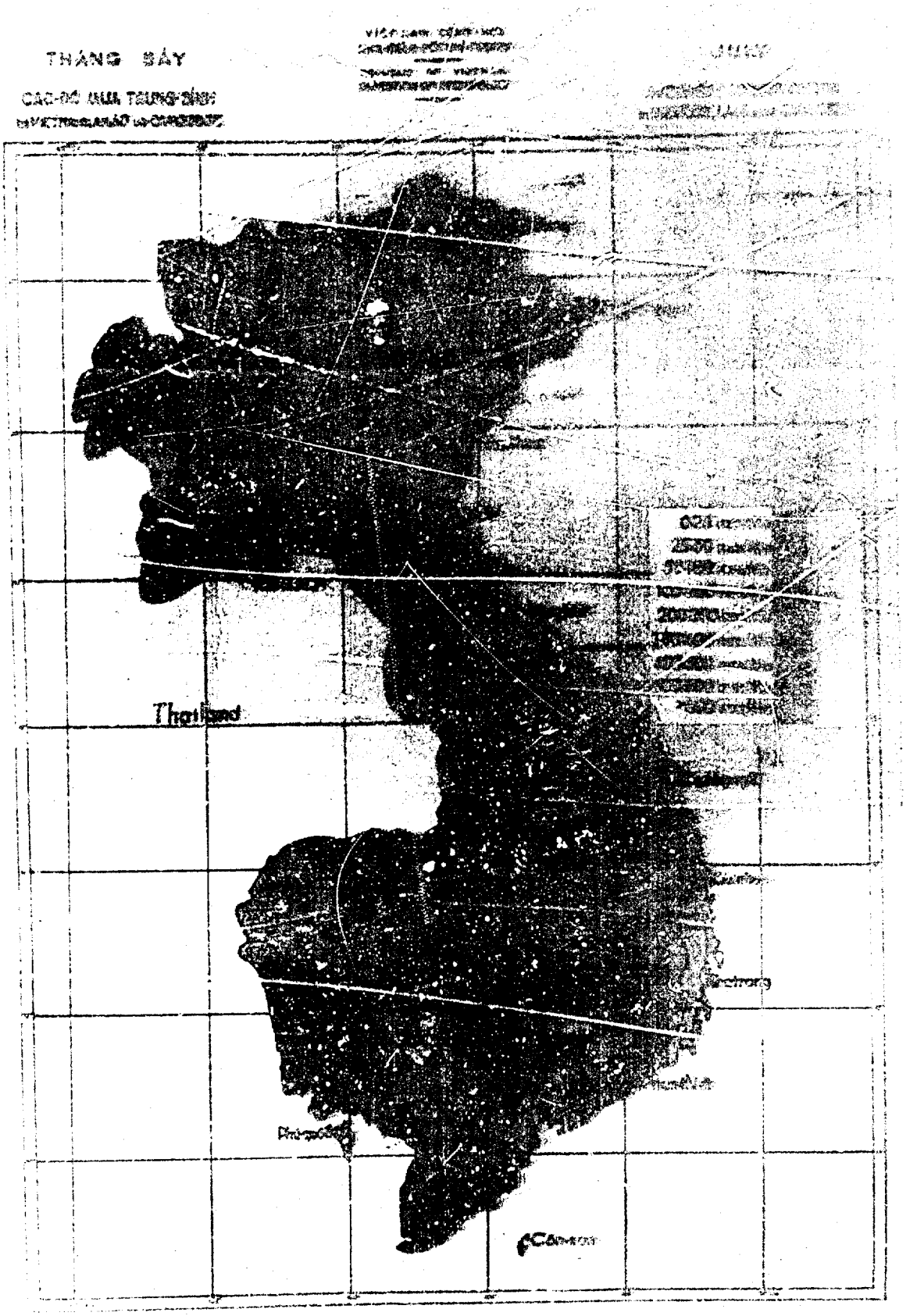
VIỆT-NAM CỘNG-HÒA
NHA GIÁM-ĐỐC KHÍ-TƯỢNG

REPUBLIC OF VIETNAM
DIRECTION OF METEOROLOGY

JUNE

AVERAGE PRECIPITATION
in VIETNAM, LAOS and CAMBODIA




THÁNG BẢY
Thailand

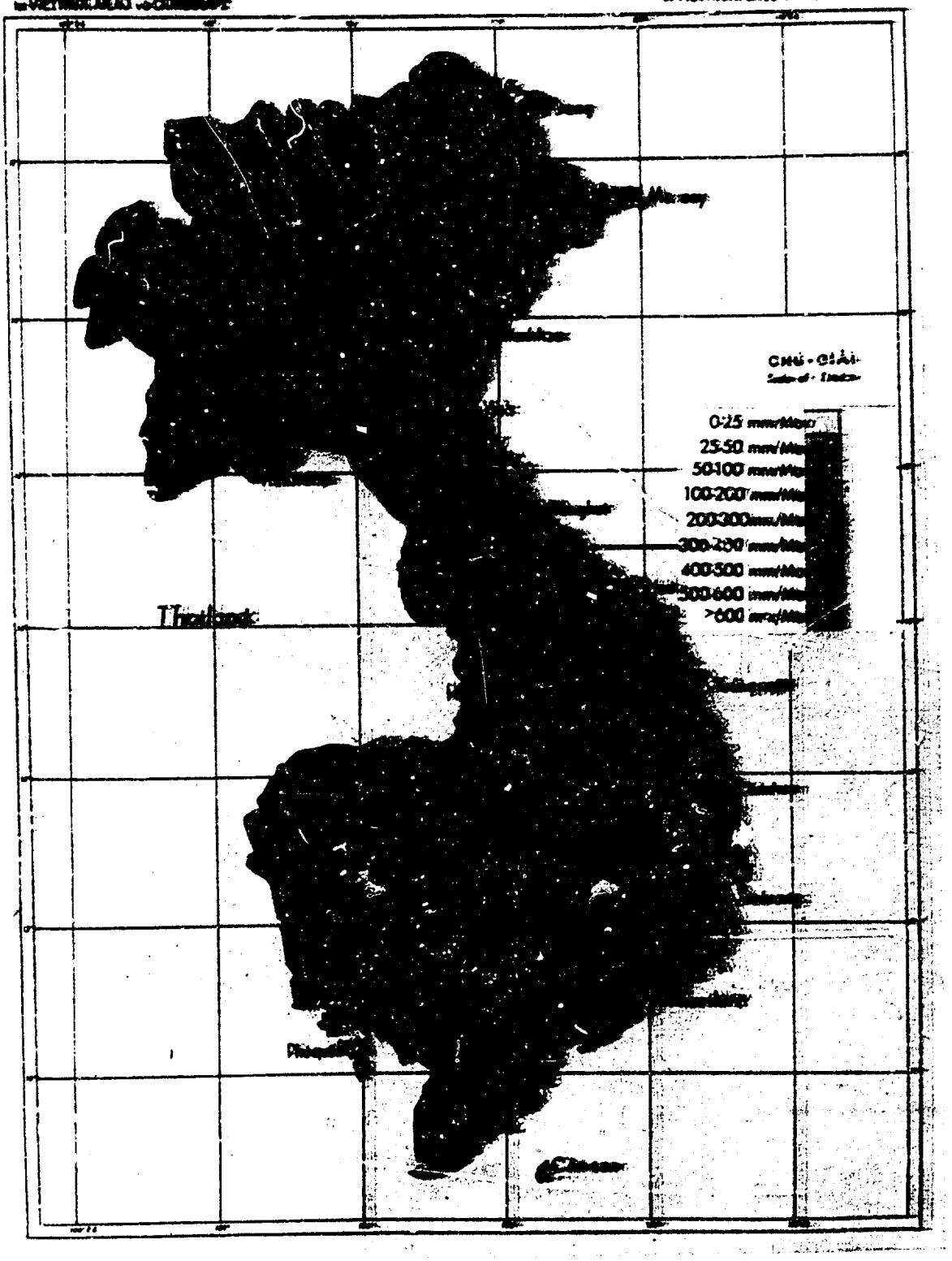
VIỆT-NAM CỘNG-HÒA

THÁNG TÁM

CAO-ĐỘ MƯA TRUNG-BÌNH

AUGUST

AVERAGE PRECIPITATION



THANG CHÍN

CAO-ĐỒ MƯA TRUNG-BÌNH
tại VIETNAM, LAO và CAMBODGE

VIỆT-NAM CỘNG-HÒA
NHA GIÁO-ĐỐC KHÍ-TƯỢNG
REPUBLIC OF VIETNAM
DIRECTION OF METEOROLOGY

SEPTEMBER

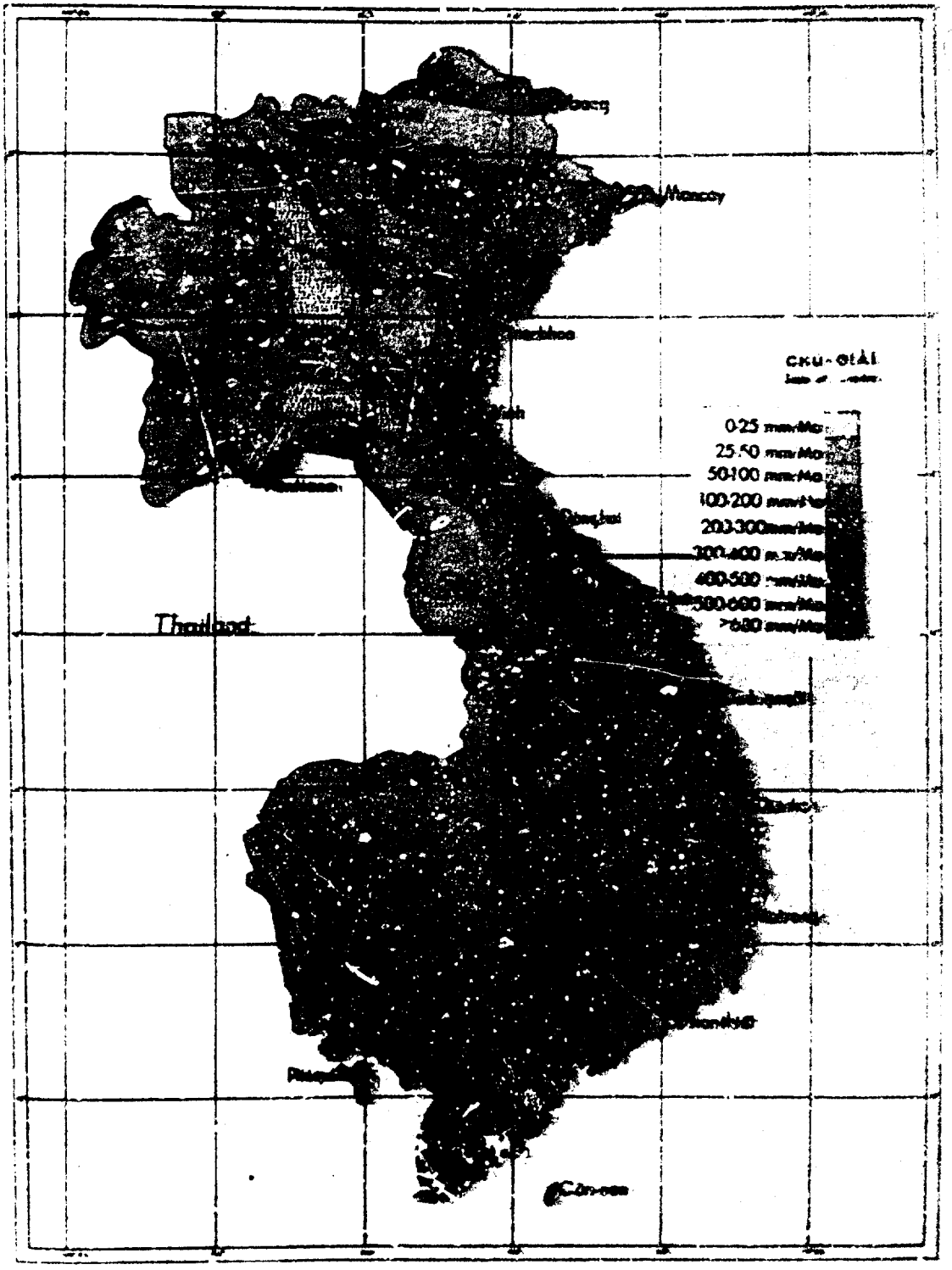
AVERAGE PRECIPITATION
in VIETNAM, LAOS and CAMBODIA

THÁNG MƯỜI

CAO-ĐỘ MƯA TRUNG-BÌNH
VIETNAM, LAOS và CAMBODGE

OCTOBER

AVERAGE PRECIPITATION
in VIETNAM, LAOS and CAMBODIA



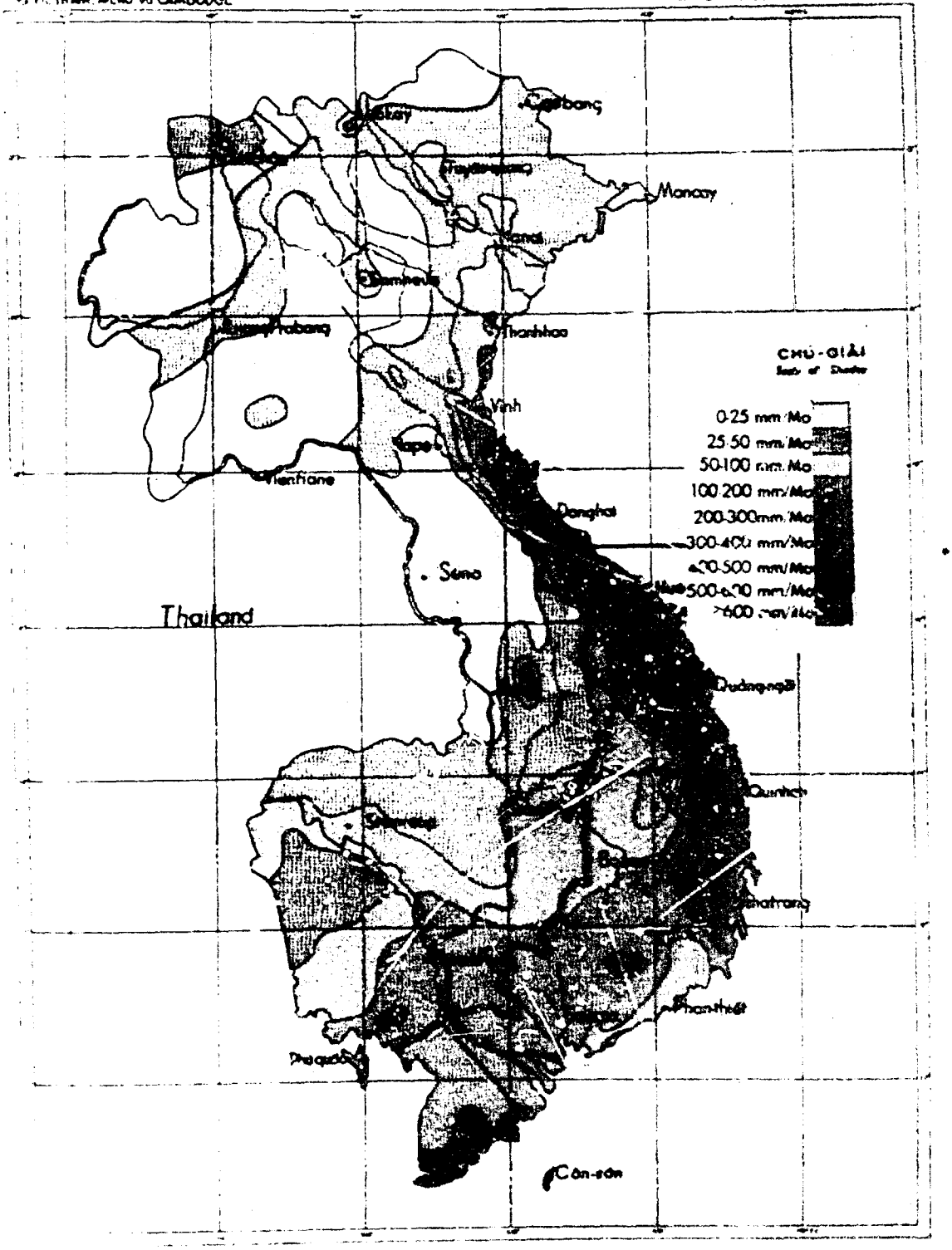
VIET NAM CONG HOA
NHA GIAM-DOC KHI-TUONG
REPUBLIC OF VIETNAM
DIRECTION OF METEOROLOGY

THANG MUOI MOT

CAO DO MUA TRUNG-BINH
o VIETNAM, AI LAO va CAMBODGE

NOVEMBER

AVERAGE PRECIPITATION
in VIETNAM, LAOS and CAMBODIA



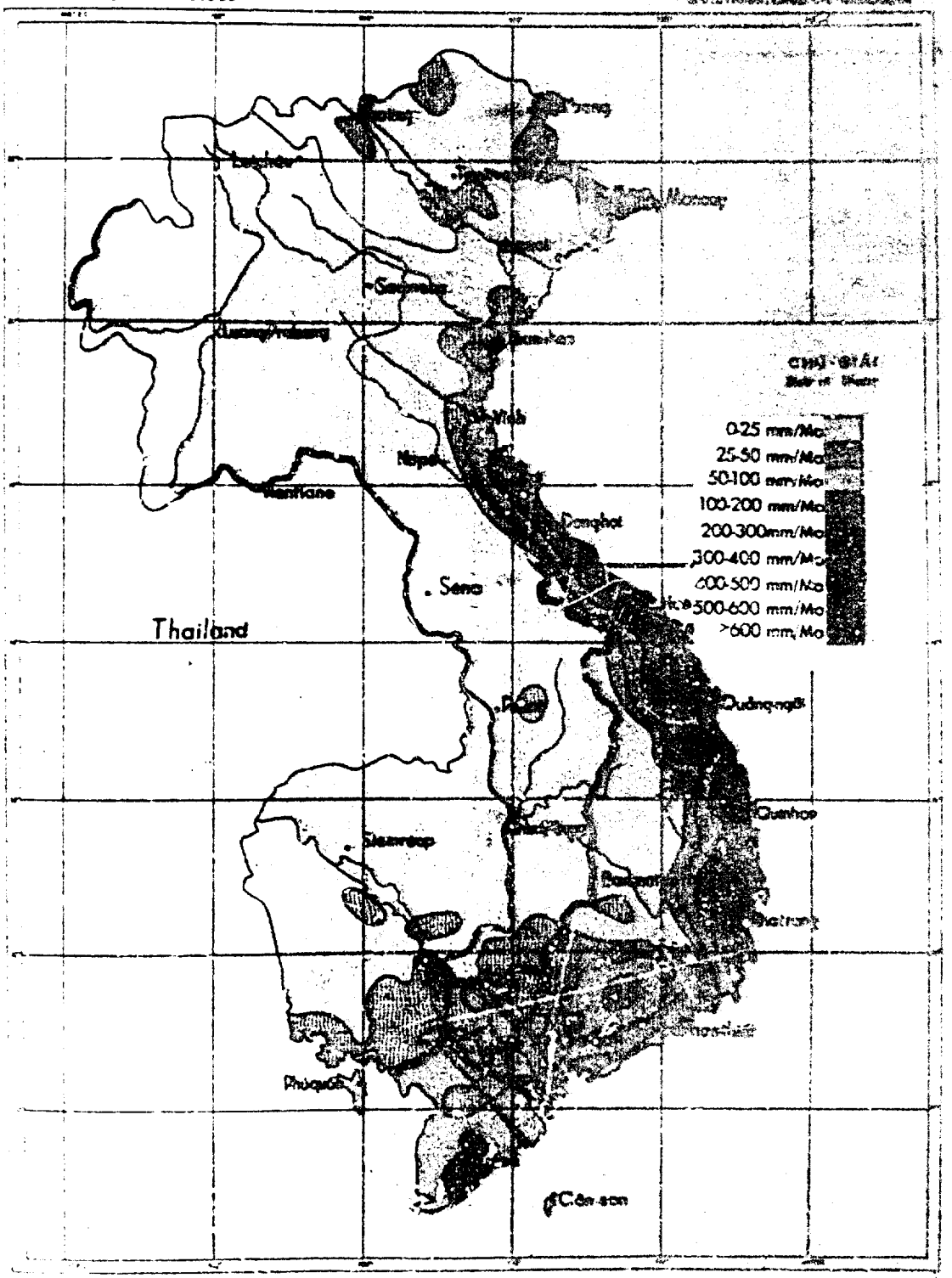
THÁNG CHẠP

CAO-ĐỘ MƯA TRUNG-BÌNH
ở VIỆT-NAM, AI-LAO và CAM-BỐT

VIỆT-NAM CỘNG-HÒA
NHA GIÁM-ĐỐC KHÍ-TƯỢNG
REPUBLIC OF VIETNAM
DIRECTION OF METEOROLOGY

DECEMBER

AVERAGE PRECIPITATION
in VIETNAM, LAOS and CAMBODIA



CAO-ĐỘ MƯA

TRUNG-BÌNH TRONG NĂM

của VIETNAM, AILAO và CAMBODGE

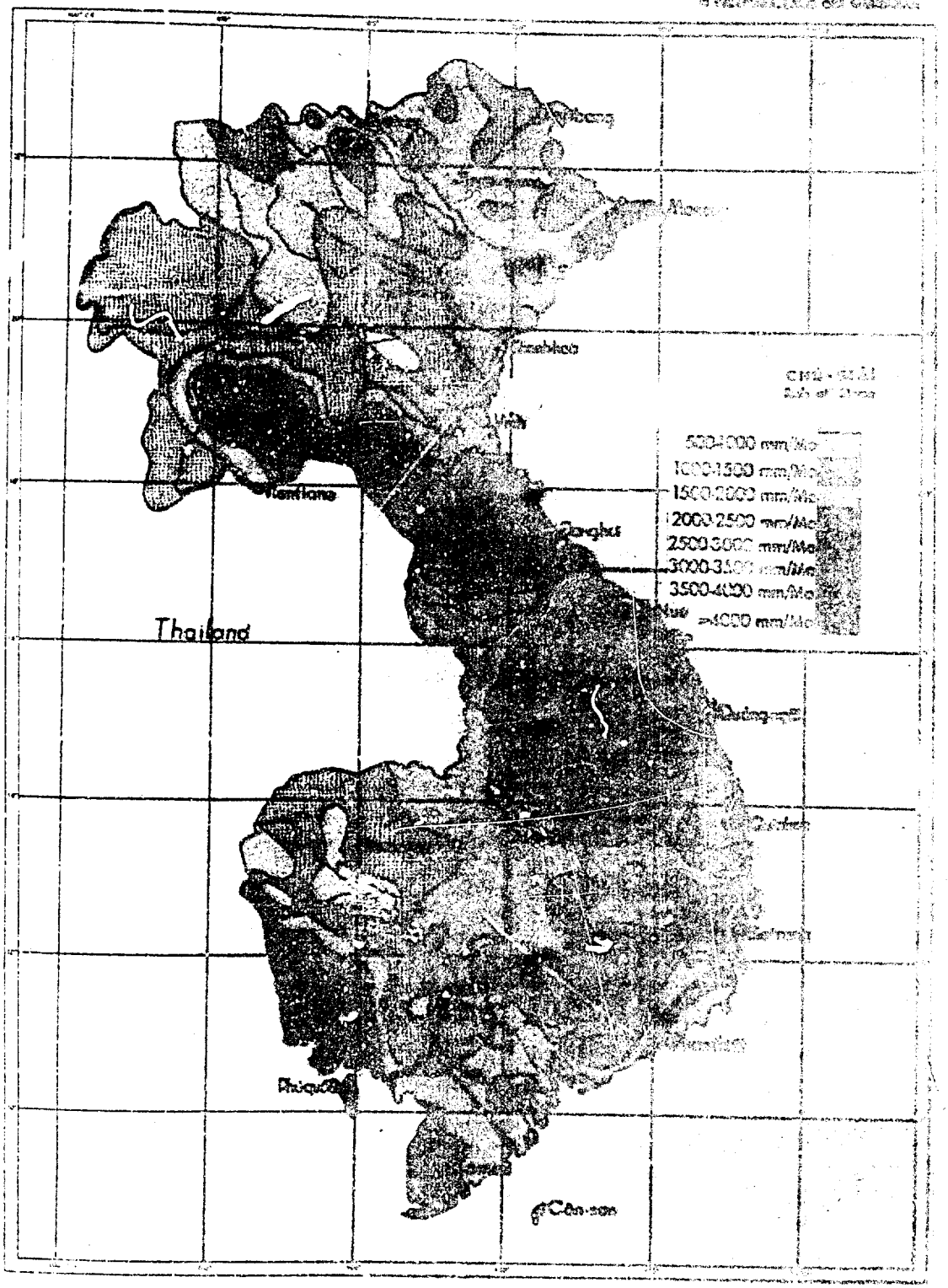
VIET NAM CỘNG-HÒA

REPUBLIC OF VIETNAM

AVERAGE

ANNUAL PRECIPITATION

in VIETNAM, LAOS and CAMBODIA



SECTION XVII

VEGETATION SPRAY INFORMATION

J. W. BROWN

February 1962

TABLE OF CONTENTS

* Several drums marked with pale pink on fading appear to have a white stripe.

[redacted]

INTRODUCTION

This paper has been prepared with the major objective of supplying information to those concerned with the use of chemical sprays to achieve effects on vegetation. The degree of interest will vary according to the reader's requirements, however, it is intended to be of help to all of those (U.S. and Vietnamese) who may be immediately and closely concerned with the problem.

Supplementary reports have been indicated where more detailed information is desired but in many cases these reports may exist in too few copies for general distribution or are not otherwise suitable for inclusion. At the present time these reports are in the files of Tasks 2 and 20 or elsewhere in the general files of MAGRD at the VN CDTC.

For general background information it is recommended that Annex A: "Defoliants" (Jan 1960, rev. July 61), be read first.

NOTE: This report was originally written in Vietnam, classified Secret at that time, and left with U.S. and VN personnel for their guidance.

I. CHEMICALS

A. CHEMICAL AND PLANT ACTIVITY

1. Purple: A 50-50 mix of 2,4-D and 2,4,5-T as follows:

50% n-butyl ester of 2,4-dichlorophenoxyacetic acid.
30% n-butyl ester of 2,4,5-trichlorophenoxyacetic acid.
20% isobutyl ester of 2,4,5-trichlorophenoxyacetic acid.

The mix of all of these chemicals consists of about 95% or more active ingredient and, for practical purposes, can be considered 100% active ingredient weighing about 10 to 11 pounds per gallon. This material is liquid and is only very slightly soluble in water but can be extended or diluted by many organic solvents, fuel or diesel oil being commonly used. For aerial dissemination the material is used directly as it comes from the drums. A characteristic of this material is that it is volatile to the extent that for a few days following dissemination the vapors are capable of causing effects on plants as well. This characteristic was incorporated to aid in achieving a greater vegetation effect where the canopies of forests were particularly dense.

The over-all action of this material is that it will kill the susceptible vegetation with which it comes in contact in sufficient quantity. With aerial dissemination, the greatest mode of entry into the internal living system of the trees is by way of the sprayed droplets impinging on the leaves. A rain occurring, say, one hour after spray deposit, will have very little if any noticeable effect on reducing the ultimate response of the vegetation. However, these chemicals require time for the response of the vegetation to occur, the most sensitive responding first, the most resistant responding last, and those species which are either immune or are unsprayed may respond only by continuing to grow. Thus, those species which are slow to respond or which do not show an apparent early response are frequently prejudged by some as being immune when in reality either more time is required by these species to respond, or they may not have received a sufficient coverage or amount of spray, or they may not be actively growing having entered a period of relative "dormancy" associated with a change of seasons. On the other hand, where desirable plants are concerned, there is an immediate tendency by some to deduce that if anything causes these plants to change appearance, it was caused by the spray. In regard to the latter situation, it should be recognized that a "pure stand" of sensitive vegetation whether it be rubber, bananas, citrus or other species, is capable of showing a relatively marked response when viewed from the air simply because there is a relatively like response capable of expression in each individual plant in the crop or area. A forest or jungle more usually presents an array of different species which can differ considerably in their rate of response and thus present a very uneven picture during the development of the response.

Sensitive trees which receive an adequate spray will respond more quickly if the application is made during a season of rapid growth. Under these conditions the translocation of the material within the plant system occurs most readily, reaching sufficient portions of the root systems to cause the death of the entire tree. This is why it is desirable not to cut or chop down trees whose tops appear to be dead within a month or so after spraying. Many tree species are capable of resprouting from the stump. The proportion of species found in Vietnamese jungles and forests which have this capability is not known. It is believed that 60 to 90 days after spraying and environmental conditions for normal growth have been prevalent, those trees which do not show signs of life could be chopped down with little risk of subsequent sprouting from the stump.

One of the most prominent responses in certain broadleaved species is a pronounced coloration in the leaves which appears much the same as "fall coloration" in the U.S. and is apparent in many unsprayed rubber plantations in Vietnam in January.

In regard to a second spray for increased effect where canopies are very dense and assuming there is insufficient spray penetration, it is not anticipated that great benefit would accrue until after the effect of the first spray has had ample opportunity to develop, otherwise leaves which received the first spray and which have not fallen will intercept portions of the second spray. A guess for planning a second spray would be about one month after the first one under conditions of active growth.

In regard to burning jungle vegetation after spraying, the spray effect should not only be fully developed but the requirements for generating a self-sustaining fire must be satisfied as well. Except in pine forests, forest fires in South Vietnam appear to be relatively rare. It is suggested that in burning attempts, particular attention be given to conditions which will aid in combustion. In January, there is a relatively large daily fluctuation in relative humidity. Attempts to burn forests would have the greatest chance of success when the relative humidity is low, has been low for at least a few hours, and is expected to remain low for a few hours. It is likely that the progress of relative humidity in a forest which has been sprayed will drop somewhat later, rise somewhat earlier, and perhaps never be quite as low as that which occurs in an open area. Also if rain has occurred in the recent past it would be well to delay attempts to burn until the foliage and leaf litter have had at least a few days to dry out again.

2. Pink* or Green: Either a 60-40 mixture or an 80-20 mixture of esters of 2,4,5-T as follows:

60% or 80% n-butyl ester of 2,4,5-trichlorophenoxyacetic acid.
40% or 20% isobutyl ester of 2,4,5-trichlorophenoxyacetic acid.

These chemicals consist of about 95 or more active ingredient and weigh about the same as the purple code material.

* Pale pink stripes on drums appear on standing exposed to the sun to become white stripes.

There is only a minor difference between the two chemicals above and for practical purposes were obtained in this form because the former crystallizes below 77° F. This chemical (the n-butyl ester) was shipped in pure form and labelled with a green stripe. After its arrival all of it was mixed with equal portions of the 60-40 mix (labelled with a pink stripe) and thus became 80-20 which will withstand lower temperatures without crystallizing. Thus, there is no reason to discriminate between drums striped with pink and those striped with green.

Their action on manioc (a root crop) is much the same as that described for purple striped material against trees, and they are in fact one-half of the active ingredient of the purple coded material. In the U.S., derivatives of 2,4,5-T (very closely related to pink or green and as in TRINOXOL) are recommended for use in eradicating many species of broadleaved trees. A very specific use in the U.S. is to prevent the growth of hardwood species in southern pine being commercially grown for pulpwood. Pines are not harmed by this chemical at rates which are lethal to many broadleaved species.

The three test swaths near Bien Hoa airport were sprayed with TRINOXOL on 17 October 1961.

3. Blue

The blue code material has as the active ingredient cacodylic acid and has a trade name of ANSAR. It is a fine white powder which must be kept dry in order to prevent caking or hardening, because it is hygroscopic. The analysis of this material is (according to correspondence from the Manufacturer):

65% Cacodylic acid (anhydrous)
30% Sodium chloride
3% Sulfates (as $Na_2 SO_4$)
2% Water

and solubility information which has been supplied by the manufacturer follows (see reference 1.):

"A clear solution results upon the addition of up to about 35 grams 'ANSAR' in 100 grams of water. This is equivalent to about 2.5 pounds of 'ANSAR' per gallon."

"At 40 grams of 'ANSAR' in 100 grams of water a very fine precipitate results which plugs a sintered glass filter having a 50 micron (maximum) pore size. The particles appear to be about 50 microns in size."

"Any additional quantity of 'ANSAR' results in further precipitation. In one test we prepared a saturated ANSAR solution and filtered off the insoluble inerts (sodium chloride and sulfates).

Approximately 20% of the total weight of 'ANSAR' added was removed by this filtering. Such a solution contains about 11.5 pounds of 'ANSAR' per gallon at 20° C."

The blue coded material is a fine, dry powder which on standing in the open will absorb moisture. Thus, it is highly advisable that handlers wear face masks to cover their mouth and nose while exposed to dust clouds of this material, and that the creation of dust clouds be avoided as much as possible.

The results of toxicity tests in the U.S. have been indicated by the manufacturer* as follows.

TOXICOLOGICAL DATA

(1) Acute Oral Toxicity

(Technical grade containing 61.29% cacodylic acid)

Pure strain, Sprague-Dawley albino rats with a mean body weight of about 105 grams were used as test animals. Six test groups of eight rats each were used. The animals were given a single calculated dose via stomach syringe and observed for two weeks. Test material was administered as a 20 percent (w/v) aqueous solution.

The acute oral mean lethal dose for the albino rat (combined sexes) was:

(a) $LD_{0.01}$ = 0.48 g./kg.

(b) LD_{50} = 1.35 g./kg.

(c) $LD_{99.99}$ = 3.90 g./kg.

(2) Dermal Irritation

Method

Albino rabbits were used for this work. They were housed in individual screen bottom cages and fed water and rabbit chow ad libitum. The hair was clipped from the back and flanks of the animal. Four areas of the back, ten centimeters apart were designated for the work; two areas were abraded by epidermal incisions and two left intact. The material was applied to each of six rabbits, three abraded areas and three intact areas, in the amount of 0.5 ml. or 0.5 gms. per area. The treated areas were covered with gauze and

* Commercial Development Department, Chemical Products Division, Ansul Chemical Company, Marinette, Wisconsin, U.S.A.

the trunk of the animal wrapped in rubberized cloth. The animals were then immobilized for a 24 hour period at which time the coverings were removed and the degree of erythema and edema were recorded on a arbitrary scale.

Conclusion

Under the test conditions outlined above the sample of cacodylic acid tested has a primary irritation index of 0.3. It may be considered to be essentially non-irritating to the skin when accidently applied topically.

(3) Eye Irritation

Method

Adult albino rabbits of the New Zealand White variety are placed in a holder such that the animals cannot rub their eyes. One tenth of a milliliter of test substances is instilled in one eye, the other untreated eye serves as a control. A series of six albino rabbits is used for each substance, (half of the animals are further treated by washing the test material from the eye with 20 cc of warm water, 2-4 seconds after treatment.)

The reaction to the test material is read according to the attached scale of scoring for damage to the cornea, iris and the bulbar and palpehrol conjunctivae after 24 hours. The animals are returned to their cages and a further reading is made at 72 hours after treatment. The average of the 24 and 72 hour readings is used for determining the total score for each sample.

Conclusion

Under the test conditions outlined above the sample of cacodylic acid tested has a ocular irritation score of 2.0. It may be considered to be essentially non-irritating to the eye when accidentally exposed.

Eye irritation and dermal irritation were run with a technical grade Ansar containing about 80% cacodylic acid on an anhydrous basis.

Additional detailed data is available as well as additional information on sub-acute toxicity and sub-acute dermal toxicity. No attempt is made here to present all of this data since it is quite extensive.

(See reference 1 for obtaining additional toxicological information).

For acute oral toxicities mentioned above, LD means lethal dose and, for example, $LD_{0.01}$ = 0.48 grams per kilogram of body weight means that if 0.48 grams were taken by mouth the statistical probability of death of an animal weighing one kilogram would be one in 10,000. The subscript is expressed in percentage.

Assuming, as is commonly done in the U.S. until more accurate information is available, that the data from tests on albino rats is applicable to man, 10,000 men weighing 50 kilograms each consumed 24 grams of ANSAR (50 X 0.48) only one man would be expected to die. Thus, this material ranks as being less toxic than DDT, a material that has been widely used as an insecticide.

The powder is readily soluble in water and a good bath with mild soap and water is considered sufficient to remove residues.

It should be clearly understood that one pound of ANSAR dissolved in one gallon of water would cause that one gallon to contain only 0.65 pounds of active ingredient at most since the final volume, although unknown, may be increased somewhat by the addition of the powder. In order to obtain a solution containing 2 pounds per gallon (roughly) of active ingredient, approximately 3 pounds of ANSAR should be contained in that gallon. Since the blue (ANSAR) is packaged in 100 pound units, this would require 600 pounds to be contained in 200 gallons. Because 200 gallons is the rated capacity of the HIDAL, (see reference 2.) it is suggested that the tank not be filled entirely(and the weight to be airborne may become limiting here as well, HIDAL weight empty is given as 505 pounds) because overflow possibilities while in flight should be avoided. With the equipment functioning at 40 pounds pressure, at an altitude of 50 to 75 feet (to obtain a 200-foot swath,) and at an airspeed of 50 knots, about 2 quarts or ½ gallon per acre will be released. Under suitable conditions for delivering the spray, approximately one pound per acre of active ingredient can be expected to be deposited on the target. Until more information is available, it is recommended that this chemical for rice be used at a rate not to exceed one pound (active ingredient) per acre. Rates this high have been applied experimentally in the U.S. without noticeable long term residual activity of the compound, that is without rendering the land unfit for use the following growing season.

B. USE OF CHEMICALS

1. For jungle, roadside, or mangrove vegetation: The drums coded with a purple stripe contain chemicals intended for this use at a deposit rate of one gallon per acre. Extreme care should be used in its release in order to prevent spraying or having the chemical drift or its vapor contact desirable plants such as rubber trees, banana trees, citrus trees or garden crops. Some of these trees or crops can be severely damaged or destroyed with as little as 1/100th of a pound per acre. The vapors from this material can also damage sensitive species as well.

For the most efficient use of the purple material, vegetative growth should be active. The action of the material is such that it interferes with the normal growth activities of the vegetation to which it has been applied.

Another chemical (coded blue) has recently (reference 1., August 1961) been indicated by the manufacturer as showing defoliating properties on cotton in the United States. Two test sprayings on 12 Jan 1962 via helicopter

in Vietnam have shown impressive results both against roadside and jungle vegetation and on grassy vegetation in an area of water-logged terrain at the VN Navy Yard, Saigon. An acre or so of the latter area was intentionally burned the 9th day after spraying to reduce a fire hazard. The jungle and roadside area was the first to be sprayed with this chemical (on 12 Jan 1962) anywhere in the world to the writer's knowledge. Thus, a calculated use rate cannot be predicted as being the most efficient without further testing. It is believed that the Vietnamese are fully capable to conduct these tests. The rate of release used in this one instance was of the order of 10 pounds of chemical (ANSAR or 6.5 pounds of active ingredient) per acre. This was achieved with an H-34 helicopter (flown by VN Captain Thap) rigged with HIDAL making 2 passes over the same area spraying ½ gallon per acre each pass for a total of 1 gallon per acre release. Ten pounds of powder were mixed per gallon of water (see section I. D. on Mixing of Chemicals). This particular chemical was originally intended only for use against rice at a rate of about 1 pound per acre (active ingredient basis).

The action of the blue material is somewhat different from the pink, purple or green in its mode of action in that at rates of about 1 pound of active ingredient per acre or higher the effect on vegetation appears to be that of a desiccant. Thus, on contact, foliage becomes dehydrated. Its use for this effect is very new and more research is needed to provide answers that must be available before unlimited recommendations can be made for spraying jungles or roadsides at higher rates. The duration of the effect of this material on trees is not known, however, it appears to have affected a very high percentage (almost all) of the species in the test swath of 12 Jan 62 near Route 15.

2. For Manioc (Tapioca) and Sweet Potatoes: The drums coded with a pink (fading to white) or green stripe contain chemicals which are intended for killing manioc at a use rate of the chemical of ½ gallon (5 pounds) per acre of manioc. To destroy sweet potatoes, an extremely sensitive crop, only one tenth of a pound (1/100 of a gallon) per acre would be required. However, using HIDAL (Helicopter Insecticide Dispersing Apparatus Liquid) it may prove inconvenient (and even unnecessary) to prepare dilutions only for sweet potatoes unless large acreages would make it worthwhile. Loaded with the undiluted chemical a single aircraft could spray either manioc or sweet potatoes in a single pass at 50 knots.

Two possibilities, however, are present where the use of hand or knapsack sprayers are proposed for use by infantry finding these crops under enemy control. These units have not yet been received but are expected during February 1962 and have been recommended not to have a capacity greater than 3 gallons. Such units are estimated to have an empty weight of 5 to 10 pounds or when loaded with undiluted chemical - 35 to 40 pounds, very near the weight limit a VN soldier can carry pushing through mountainous or jungle terrain. One unit load (3 gallons) of undiluted chemical would be sufficient for 6 acres of manioc or 300 acres of sweet potatoes but it becomes readily apparent that it would be extremely difficult to distribute only 3 gallons

of the chemical evenly over 6 acres not to mention 300 acres. Dilution of the material is possible with diesel fuel or other petroleum solvents but this would mean other soldiers, perhaps, would have to carry this diluent. An "experience" factor may have to be found to determine whether and how much the concentrate should be diluted before loading these spray units to gain the most efficient use of these chemicals. For example, an acre is about 70 X 70 yards (64 X 64 meters) and determinations will have to be made for:

a. How much area a man can spray in what length of time.
b. How long does it take on the average to spray 3 gallons out of the sprayer.
c. How many gallons are needed to cover an acre.

From this information a suitable dilution may be indicated, for instance, if it is determined a man can spray a 6-foot swath (2 yards) 210 feet long (70 yards) with 1 gallon, then 70/2 = 35 gallons would be needed to cover 1 acre, and one-half gallon of chemical mixed with 34½ gallons of diluent would be needed for an acre of manioc. In actuality, a man may be able to spray a wider swath of the same length with one gallon and, if so, the dilution would not have to be as great. NOTE: Destruction of crops by this method requires a smaller expenditure of manpower than by any other hand method. If helicopters equipped with HIDAL are made available for this work, crops above one acre in size can be destroyed with an even greater saving in manpower and chemicals.

3. For Rice: Although the unintentional spraying of rice near Dak To with TRINOXOL at a rate of about 6 pounds per acre resulted in reports that the rice was killed in 2 days, (12 Aug 61) and was indeed a sickly looking crop 2 months after spraying (11 Oct 61), final yield results are not known to the writer despite requests for this information. An estimate is that 90 percent of the rice sprayed was destroyed.

At the time of the above spraying (10 Aug 61) rice was not indicated as a target crop of interest but almost immediately became one after the spray result. A different chemical (code blue) would have been indicated otherwise. At 1/10th of a pound per acre and depending upon a relatively precise selection of the stage of growth of the rice, high yield reductions have been obtained experimentally on acre plots in the U.S. At rates this low the action of the chemical is one of inducing sterility, however, but as indicated above, the timing of the spray is rather critical. It is recommended that a rate of about one pound per acre of active ingredient be used. At this level, the action of the chemical will approach that of a desiccant with the attendant possibility of burning the rice crop at a time when it would ordinarily be green and growing.

Rice is a crop which sometime after planting (or transplanting) produces additional stems from the roots (called "tillers") and it is advised to spray after these have appeared and are well along in their growth,

otherwise spraying should be accomplished about one month or 6 weeks after planting to kill the seedling plant. With the blue code material it appears that spraying up to within 3 weeks of harvest would be indicated.

C. PRECAUTIONS IN HANDLING

Purple, Pink and Green Materials

The basic ingredients of the purple, pink (or white) and green coded materials have been used in large quantities for several years in the United States and their use will undoubtedly continue. During this time many people have been exposed to them in their manufacture and use. Under these conditions harmful effects to humans have had ample opportunity to be expressed. Moreover, large scale use of these ingredients has continued for many years, aiding in the production of wheat, rye, corn, hay and other economic and food crops by spraying these crops to destroy weeds. One can surely conclude, therefore, that for their intended use, these products are not directly harmful to humans or to animals.

Only normal sanitary precautions are required when handling these liquid chemicals, that is, washing with mild soap to remove residues from exposed skin. In the event a worker should get liberally splashed with these products, there is no immediate cause for alarm, but it is not advisable that this man be required to continue to work a full day without an opportunity to wash and change clothes. Gasoline or a like solvent will quickly remove these materials from clothing and care should be taken when using these means not to set the clothing on fire.

Under no conditions should anyone drink these materials, any more than they should drink gasoline, fuel oil or many other liquids commonly encountered in daily life.

People who may be subjected to sprays or vapors of these sprays have no reason to become fearful or alarmed.

D. MIXING OF CHEMICALS

1. For pink, purple or green code chemicals mixing is not necessary for aerial release. Dilutions could be used for hand spraying (see I. B. 2.).

2. Blue Code: A tank (capacity of not less than 100 gallons) with an agitator and a large opening (approximately 14 inches) is desirable. The agitator is a necessity in speeding the mixing operation and the large opening in tank is a convenience for emptying the drums of powder. The agitator should be driven by a motor. Dust masks should be worn by handlers of the dry powder.

a. First pour the required amount of clean water (water containing debris will clog the filters on "HIDAL" rig) into the tank and start the agitator. Pour the powder in slowly allowing the agitator to mix it thoroughly.

b. After mixing is complete the slurry should be pumped into drums (if additional quantities are to be mixed immediately) and allowed to set about 15 to 30 minutes. Some white material may settle out after the drums have set for the above period. This precipitate in the drums is not needed thus remixing or handling drums in a manner that will cause remixing is cautioned against. When the chemical is pumped from the drums keep the suction end of the hose approximately six inches from bottom of drum. The remaining solid material in the drum is discarded. This precipitate will consist largely of sodium chloride, calcium sulfate, sodium sulfate and a small amount of cacodylic acid, all of which are water soluble and an earthen pit is suggested for waste disposal. A secure fence should be erected around this pit to prevent unauthorized entry or accidents to children or animals.

c. All pumps for transfer of chemical and the mixing tank should be cleaned with water after use; particularly if they have brass components.

d. All handlers of the chemical should wash or shower as soon as expedient to remove residues of the chemicals. These are just normal sanitary precautions.

II. EQUIPMENT MAINTENANCE

A. MAINTENANCE FOR "HIDAL" RIG

Pink, Purple and Green Code Material

1. When using pink, purple or green code material some maintenance will be required for the HIDAL.

2. For each 1,000 gallons of these chemicals dispensed by this system, the master filter (located under the tank) and filters in each nozzle, nozzle tips, and individual diaphragm check valves should be removed and cleaned in a solvent. Rubber diaphragms should be inspected for breaks or softening of the rubber. If such occurs these should be replaced.

3. The nozzle tips should always be adjusted so that the nozzle slit opening and the flat spray pattern are parallel to the boom.

4. No adjustment is necessary to the diaphragm end of the nozzle except to be sure that the retainer is tightly locked by the spring clip. When diaphragm is to be removed be sure spring clip is depressed before turning diaphragm or damage will result to spring clip.

5. Never operate the HIDAL pump without solution in the tank. The solution lubricates the pump.

6. If the system is to be idle for one day or more, 10 gallons of diesel oil should be used to flush the system. Part of the oil should be kept in the system. In cleaning operations, care should be taken to prevent chemical residues from contacting desirable vegetation either by spray, spray drift, or as liquid.

7. If the booms are to be removed from the aircraft they should be drained of diesel oil prior to removal.

Blue Code Material

1. The blue chemical is very corrosive to brass and special maintenance must be performed or damage to the equipment will result.

2. The blue chemical is soluble in water, thus a thorough flushing (with not less than 50 gallons of water) is recommended after each day's operation. This should be followed by pumping 10 gallons of diesel fuel through the system. The diesel fuel will help prevent corrosion should small amounts of chemical remain in the system.

3. Filters, nozzle tip, and diaphragm should be removed and cleaned, in water, after using each 1,000 gallons of chemical or sooner if clogged nozzles are observed, or before the equipment is to be stored or allowed to

stand for more than two days. After the system is cleaned with water the nozzles should be reassembled and diesel fuel pumped through it.

4. The nozzle tips should always be adjusted so that the nozzle slit opening and the flat spray pattern are parallel to the boom.

5. In cleaning operations care should be taken to prevent chemical residues from contacting desirable vegetation either by spray, spray drift, or as liquid.

(See reference 2.)

B. MAINTENANCE FOR BUFFALO TURBINE SPRAYER

1. After use with either pink, purple or green code chemical the system should be flushed with about one gallon of diesel fuel if it is expected that it will stand idle for more than two days.

2. After use with blue code chemical, first flush the system with water then with about one gallon of diesel fuel.

3. Weekly cleaning of main filter is recommended.

4. When storing unit for a long period of time, rust inhibitor should be added to the pump.

5. Normal maintenance only is required for the motor.

6. In cleaning operations care should be taken to prevent residues from contacting desirable vegetation either by spray, spray drift, or as a liquid.

C. MAINTENANCE FOR A-6 TRANSFER PUMPS

Pink, Purple and Green Code Material

1. Prior to the storage of or non-use of pump for several days at a time, diesel oil should be pumped through the system. The above chemicals cause a slight corrosion standing in the pump and thus make the pump inoperable until it is freed by hand. Diesel oil in the pump system can prevent this trouble.

2. Normal maintenance is required for the gasoline motor.

Blue Code Material

1. After each day's use the pump should be flushed with water to remove all chemical.

2. Prior to storage, diesel oil should be pumped through the system to prevent corrosion and "freezing" of the pump.

D. MAINTENANCE FOR C-47 SPRAY SYSTEM

See reference 4. for spray pilot instructions, operation and maintenance for this system.

It is recommended that blue code material not be used in this system because of its corrosive properties.

REFERENCES

1. Product Report "ANSAR - Cacodylic Acid." A report on the experimental use of ANSAR as a cotton defoliant. Ansul Chemical Company, Marinette, Wisconsin, August 1, 1961.

2. Technical literature on HIDAL (Helicopter Insecticide Dispersal Apparatus, Liquid), already made available to VN Helicopter Section.

3. Technical literature on Buffalo Turbine.

4. "S.O.P. for Spray Pilots," (Previously distributed to VN C-47 pilots who have received instruction) and technical literature at CDTC.

ANNEX A

DEFOLIANTS

The materials described and discussed below need not make agricultural land unproductive for more than a few months. The application of much larger quantities of some of these materials could extend the period of nonproductivity. It should be kept in mind that many agricultural crops may be sensitive to these materials and care should be taken that spray drifts contact only the vegetation of interest.

DEFINITIONS

A true defoliant is an agent which will cause the leaves to separate and fall from the vegetation to which it has been applied. Defoliation is usually thought of as initiating a process, regardless of season, which usually occurs naturally in most temperate zone deciduous (sheds leaves annually) species in the fall of the year. The actual separation of the leaves from the vegetation is dependent on growth processes occurring in a particular few layers of cells at the point of attachment of the leaves to the plant. These cells are known as an abscission (separation) layer. Normally, natural leaf fall occurs over an extended period, say one to two weeks or more. However, in some species as in certain oaks the leaves may die and shrivel but remain attached throughout the winter until separation may be forced by the expanding buds the following spring. Growth regulator type chemicals are known which will substantially delay abscission (separation) of certain species. Chemicals, too, are known which can induce and hasten unseasonal abscission by certain species. However, we do not have a compound which will provide complete defoliation of all vegetation, say, in 3 days or less. A compound of this kind remains yet to be discovered. Although repeated defoliation by insects or other natural causes will ultimately cause the death of vegetation, most species appear capable of recovery unless there is a physiological decline already existent in individual deciduous species which are approaching death.

A desiccant can be defined as an agent which essentially dries up the plant foliage. Here, too, there is a range of susceptibility shown by various species of this type of action.

Rapid chemical dessication (drying) of foliage does not invariably lead to leaf drop, on the contrary, leaf drop may be somewhat delayed. The possibility does exist, however, of following such chemical treatment with fire. It is conceivable that a self-sustaining fire could be initiated within 24 to 48 hours and clear the area of foliage if rainy or otherwise damp weather did not interfere. If burning is not included, the dry shrivelled foliage will essentially remain in place until removed by some other means. From an observational point of view, visibility in the area may or may not be noticeably improved. More important perhaps is the fact that by using a foliage desiccant the color of the foliage will noticeably change within

minutes to a few hours, depending on the species and agent. This feature is readily apparent from the air. The use of desiccant would not necessarily be very effective in killing vegetation unless extended repeated applications were employed.

Vegetation control agents are generally considered to be those agents which when applied to vegetation will ultimately cause the death of either all or a selected portion of that vegetation. There are chemicals which are indiscriminate in killing plants, while other can selectively kill. By manipulating dosage of certain compounds either effect can be achieved. Other compounds for all practical purposes are selective. In most instances those compounds of which minimal amounts are required for selective killing, are growth regulating chemicals and may require two weeks to a month to do the job depending on the particular species, its age, environment, and vigor of growth. Preferably one compound or a suitable mixture of effective compounds would be desirable. Additionally, such compounds or preparations should be non-toxic to using personnel, non-corrosive, capable of long storage, require a minimum of special handling and be capable of aerial or ground dissemination.

USES FOR DEFOLIANTS (AND/OR DESICCANTS)

Agents of this type could prove very useful in decreasing enemy concealment or in denying areas of concealment to the enemy. By defoliation in a hardwood forest visibility could approach that in such a forest in winter. (At Camp Drum the story was told of an outfit that moved into position under cover of darkness only to find the next morning they were among trees without leaves which had been sprayed the previous year and had to move again.)

Enemy fortifications would be capable of exposure if artificially camouflaged and more readily located via improved visibility if camouflaged with natural materials.

Artificial camouflage intended to blend with green foliage would be unaffected by a desiccant while the surrounding green vegetation could take on a brown hue. The rapidity of action varies with species but some species have, on treatment with a desiccant, essentially stabilized at a different color in 15 minutes to one-half hour.

USES FOR TARGET MARKING AGENTS

Desiccants or pigmented agents could be useful for marking specific targets by artillery shell fills or for marking reference points for artillery fire.

Aerial spray of these agents would mark bomb release line, preventing damage to friendly forces. Visibility course markers could be provided for pilots to and from target areas.

General considerations pertinent to these kinds of operation would include the permeance required for the mark and the desirability perhaps of utilizing different colors for different purposes.

Agents of this kind would not mask the target from aerial view as may occur on occasion where smokes are utilized.

USES FOR VEGETATION CONTROL AGENTS

When vegetation may be particularly dense adjacent to roads or trails used to supply friendly forces, ambushes by guerrilla forces would be more difficult if the vegetation were reduced by suitable control agents. Tank trucks with high pressure spray rigs could hose both sides of a jungle road on one pass and thus gain considerable subsequent visibility adjacent to the road.

Units could reduce the likelihood of having their positions infiltrated by using chemicals to clear the waist-high types of vegetation for suitable distances around their positions.

A chemical spray could be used to mark a safe path through a mine field. Vegetation control agents could prove useful in locating mines by reducing the obscuring vegetation.

Other uses include peacetime maintenance of posts, camps, and stations, clearing fence rows and increasing ground visibility where needed around sensitive missile sites. Bombing ranges could be clearly marked. Vegetation-obscurity could be reduced in artillery impact areas for better observation during training exercises.

DISSEMINATION

The vehicles, equipment, kind of agent and amounts required, etc., for the various operations described vary considerably and may range from several aircraft with large capacity spray systems for considerable area coverage (several-hundred square miles) to one man with a portable spray rig doing a special job of eradication on the ground.

Thus, several possibilities are apparent. Helicopters, suitably equipped, have much to offer as a means of disseminating chemicals for special purposes such as perhaps spraying mine fields, enemy jungle gardens, opening up vegetation obscuring jungle trails, marking vegetation for use as guide markers for attack aircraft to and from target areas, etc.

Light or medium aircraft could usefully make bomb release lines, spray vegetation adjacent to roads to minimize ambush opportunities.

Aircraft of heavier capacity would be used for area coverage problems where large quantities of agent might be required. For instance, using a suitable agent the 38th parallel could have been delineated on the ground in Korea.

Artillery shell fills could be used to spot targets and reference points.

Trucks suitably equipped could feasibly spray roadsides of lines of supply and men on foot with portable rigs could follow mine detectors and mark a safe path through mine fields as well as perform a variety of peacetime uses such as eradicating poison ivy in training areas where trainees on night problems crawl through or sleep in such infestations. (Poison ivy was a cause of concern for Chief Medical Officer, Hq. 1st Army for man days lost in training.) Special Forces personnel could mark on the ground suitable areas for their airdrop of supplies. They could also make off-target guide marks for special targets subject to air strike.

SECTION XVIII

BURNING

20 March 1962

The writer is aware of the interest in burning previously sprayed vegetation, especially where foliage has dried as a result of spray but has not fallen. He disqualified himself as an expert on burning, but did offer to provide test swaths for others for burning tests. In fact, the three swaths at Bien Hoa sprayed on 17 October near the airport were planned for ultimate burning tests. It was later decided by others that this area was unsafe for these tests. Another site, sprayed 29 December, could have been used for this purpose but the spray release appears to have been unduly dissipated. In any case, permission to burn in this area was withdrawn by the Vietnamese because it was considered an unsafe area.

Small plots and a larger grassy area at the VN Navy Yard were sprayed with cacodylic acid and successfully burned by others ten days later.

Plans were made by others to burn in a "safe" area sprayed 13 January 1962 by USAF personnel. The combination of sublethal spray and approach of dormancy of the vegetation apparently contributed to lack of representative spray effect. Nevertheless, to the writer's knowledge, this is where burning attempts will be made. Failure to burn will in all likelihood result in a further condemnation of the spray despite the fact the foliage was still obviously green when the first burning trials were planned by others.

There was indisputable evidence presented that the adjacent unsprayed forest would not burn on 2 February when a C-123 unfortunately crashed in the forest and burned fiercely.

On 10 February further evidence was presented that the sprayed forest would not burn when debris bulldozed back from Route 15 was observed burning fiercely at the forest's edge.

It should be noted that jungle forest fires are relatively rare occurrences in Vietnam. A forest fire hazard does exist in the dry season in the pine forests near Dalat. Grass fires do occur and controlled burning of grasses is common in the dry season.

Even in the dry season, however, the relative humidity varies from saturation to 20 to 30 per cent for at most about six to eight hours of the day, according to two hygrographs recording over a two-week period in early January. These instruments were located under a shelter half (half a pup tent) staked a foot or so above the instruments. The instruments were not more than about two inches above the ground in an unforested area beside a guard tower adjacent to Route 15. The humidity, according to these instruments, seldom declined before 1000 hours.

SECTION XIX

MEMORANDUM FOR RECORD

CMLRD-BL-13-C 12 December 1961

SUBJECT: Meeting with Mr. William Godel on 4 December 1961 (U)

1. (U) Mr. Godel, Deputy Director of Advanced Research Projects Agency, DOD, requested Dr. James W. Brown to come to Washington on 4 December 1961, to receive instructions on his responsibilities for the operations to be conducted in a friendly country.

2. (S) Mr. Godel stated that approval had been given for the three phase operation based on the recommendations of Deputy Secretary of Defense and Secretary of State. Dr. Brown would be technically responsible for the entire operation. All plans would require his approval prior to execution. If he did not approve they would not be carried out. He was told that he was the representative of the Secretary of Defense and for purposes of this operation ranked all military personnel including the Chief of the Military Assistance Advisory Group.

3. (C) Dr. Brown was charged with approving the wording of the leaflets that were to be dropped prior to the operation.

4. (C) He was told that he was personally responsible for assurance that the food crop operations would not occur until food supplies were on hand to replace those destroyed.

5. (C) He was instructed to use napalm to burn foliage after treatment with defoliants. This necessitates some R&D to determine the time required for drying prior to use of incendiaries to produce a self-perpetuating fire.

6. (C) He was told to hold up operations until the friendly country was in a position to exploit to the maximum the advantages obtained by the two operations.

7. (C) He was advised to be ignorant of all other technical matters. If friendly authorities requested information on biological anticrop or antipersonnel agents or chemical agents or protective measures or detection kits, etc, etc. he was to state he knew nothing about them and suggest that they direct their inquiries to Chief MAAG.

8. (U) Dr. Brown asked if all others connected with the operation were aware of Dr. Brown's responsibilities and authority and Mr. Godel indicated that they were or would be before Dr. Brown arrived at destination.

9. (U) Dr. Brown requested a document outlining his charge and was told that such a paper would be awaiting him in the friendly country.

C. E. MINARIK
Chief, Crops Division
ext. 2202

Copy to:
Commanding Officer
Dr. J. W. Brown, MAAG

SUPPLEMENTARY

INFORMATION